INC.

IHI TECHNOLOGY TRANSFER
AT
AVONDALE SHIPYARDS, INC.
UNDER THE
NATIONAL SHIPBUILDING RESEARCH PROGRAM

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **1982**	2. REPORT TYPE	3. DATES COVERED **00-00-1982 to 00-00-1982**

4. TITLE AND SUBTITLE **Design Engineering for Zone Outfitting**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Surface Warfare Center CD,Code 2230 -Design Integration Tower,9500 MacArthur Blvd Bldg 192 Room 128,Bethesda,MD,20817-5700**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR’S ACRONYM(S)
	11. SPONSOR/MONITOR’S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**		**295**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

DESIGN ENGINEERING FOR ZONE OUTFITTING
AVONDALE SHIPYARDS, INC.

AGENDA

First Day - July 21, 1982

07:30 - 08:-00	Coffee
08:00 - 08:30	Overview and Background O. Gatlin
08:30 - 09:15	Engineering Introduction T. Doussan
09:15 - 10:00	Pre:Contract Effort and Key Plans A. Nierenberg
10:00 - 10:15	Coffee
10:15 - 10:45	Design Section (Key Plans) D. Niolet
10:45 - 11:45	Hull Section (Yard Plans) W. Seibert
11:45 - 13:oo	Lunch
13:00 - 13:15	Mechanical Design Section. A. Nierenberg
13:15 - 14:30	Piping and HVAC Section S. Caronna
14:30 - 15:00	Outfitting Section. W. Calvin
15:00 - 15:30	Electrical Section D. Mouney
15:30 - 15:45	Coffee
15:45 - 16:15	Engrg. planning & Scheduling Section J. Busch
16:15-16:45	Questions/Discussion

Second Day - July 22, 1982

08:00 - 08:30	Coffee
08:30 - 09:00	Production Planning Interface C. Starkenburg
09:00 - 09 :30	Mold Loft Interface B. Pourciau
09:30 - 10:00	Material Control Interface D. Decedue
10:00 - 10:15	Coffee
10:15 - 11:00	Accuracy Control Interface J. Taylor
11:00 - 11:45	Questions/Discussion
11:45 - 13:00	Lunch
13:00 -	Shipyard Tour

DESIGN ENGINEERING FOR ZONE OUTFITTING
AVONDALE SHIPYARDS, INC.

BACKGROUND AND INTRODUCTION

Prepared by: O. H. GATLIN

DESIGN ENGINEERING FOR ZONE OUTFITTING
BACKGROUND AND INTRODUCTION

I. INTRODUCTION

MarAd, over the past several years, sponsored a series of studies on the level of technology. In fiscal year 1980, MarAd and Avondale cooperated on a "Technical Evaluation of Avondale's Production Operations and Organization, the Development of a Long Range Facilities Plan, and the Integration of Both," under Contract No. MA-80-DOC-01017. The technical evaluation of Avondale's Production Operations and Organization was performed by Ishikawajima-Harima Heavy Industries (IHI) . In this study, Avondale concluded that they could significantly improve their productivity by using the IHI technology. But, there are so many areas that could be affected - many of which are outside the shipyard control - that Avondale could not implement all of the recommended changes at one time.

In order to improve productivity the most with the least amount of disruption, Avondale proposed to implement four of the IHI systems recommended in the Technical Evaluation. They are:

- Accuracy Control

- Production Planning

- ~~Computer Application~~

- Design Engineering for Zone Outfitting with Procurement Specifications.

This effort was to be a demonstration intended not only for the benefit of Avondale, but of all U.S. shipyards. Avondale was required to work closely with MarAd and the U.S. shipbuilding community to insure adequate dissemination of all information.

II. OBJECTIVES

The objectives were to decrease the time between the contract date and ship delivery and to increase productivity and reduce cost .

The following specific objectives arose out of the Technology Evaluation:

- implement the IHI system of accuracy control at Avondale;

- implement the IHI system of production planning at Avondale;

- implement the IHI system of computer application at Avondale;

- implement the IHI system of design engineering with procurement specifications at Avondale.

Each of the four systems were broad and extensive. In order to implement the systems, the following action was taken:

A) We selected the specific elements within each of the four systems which realize the most significant improvement in productivity with the least amount of disruption during the integration period.

B) We determined to what extent the selected elements must be tailored for adoption for Avondale and for use as an Americanized version of Japanese technology.

C) We determined what elements of the four systems are measurable and that a comparison can be made between the method previously being used and the method finally adopted.

We will tell you the organization adjustment problems encountered and how they were overcome.

The subject of this seminar is Design Engineering for Zone Outfitting. An agenda of the seminar is included in the handbook. For future planning purposes, all the seminars we plan to hold are scheduled as follows:

- Production Planning & Scheduling	-	May 18-19, 1982 (Complete)
- Design Engineering for Zone Outfitting		July 21-22, 1982
- Production Control Lofting, Accuracy Control & Line Heating	-	November 3-4, 1982

Each seminar is organized to cover in-depth the primary subject. Additionally, we will present the influence or interface and effects of Design Engineering for Outfitting to the other departments or subject areas.

This may not be the best approach; however, we feel it is suitable to demonstrate that implementing this technology requires that all departments of a company must work as a team and re-align their thinking in order to succeed.

DESIGN ENGINEERING FOR ZONE OUTFITTING
AVONDALE SHIPYARDS, INC.

ENGINEERING INTRODUCTION

DESIGN ENGINEERING FOR ZONE OUTFITTING
ENGINEERING INTRODUCTION

I am pleased to say that Avondale Engineering has successfully met the challenges posed by zone outfitting technology. We hope today to give you some idea of the scope of the challenge presented to Avondale Engineering by zone outfitting and the changes that resulted from our efforts to implement this new technology.

I will provide a bit of a background as to some of the basic concepts of zone outfitting technology. My presentation will be followed by that of our Assistant Chief Engineer, Alan Nierenberg, who will speak on Pre-Contract Effort and Key Plans. Then, each of our section leaders or their representative will speak about the particular experiences encountered in the implementation of zone outfitting for their section.

The apparent benefits of zone outfitting as practiced by Japanese shipbuilders, and IHI in particular, are shorter production times and less cost. In fact, the productivity improvements over the U.S. yards are so great that the first impulse is to produce a carbon copy of their system. Their system in its entirety, however, includes facets over which a single U.S. shipbuilder, or even a group of shipbuilders, has little or no control. Such facets even reach into the sociological and cultural make-up of Japanese versus American society - for example, the relationship of employee and employer which produces very little mobility of employees. We found that the average length of service of an IHI Shipyard Engineering employee was about 18 years, whereas at Avondale it is about 8 years. An employee in Japan is considered unreliable if he changes employers, except in rare instances. Another aspect of the Japanese system that cannot be readily reproduced in this country is their extensive use of <u>industry standards</u> Avondale's approach, then, was to study the underlying concepts of the IHI zone outfitting technology and to select those concepts that could be applied or could be modified and applied to our particular environment at Avondale.

Up until a few years ago, Engineering at Avondale followed what I will call the "Conventional System Approach." All drawings were developed to describe a single system or entity such as: the Main Deck, Transverse Bulkheads, Bilge and Ballast System, the Fire Main System, etc. A drawing seldomed mixed components within a craft and rarely mixed crafts on the same drawing. This systems approach was adequate for the production philosophy where, basically, the ship was built in sections and these sections were assembled into a complete hull before most of the outfitting material was install Outfitting material in this context refers to all the components other than basic steelwork. Production ship scheduling was, therefore, steel-work oriented. Piping and other outfit materia were generally added only after the hull was complete, except in cases where the outfit material had to be installed as productio progressed. This system approach was underscored because Engineering's development of outfit drawings always lagged substantially behind the hull development.

Avondale's application of zone outfitting technology essentially requires that all aspects of the ship be developed concurrently. The focus of Engineering is on Production and productivity. The general intent is that the ship be built in sections called "uni and that these units be outfitted as they are being built. You find as the seminar progresses that units are further divided in "sub-units" and then "partial sub-units."

Following are the definitions of some terms you will be hearing lot of today:

> A "unit" is a structural portion of the ship. Its dimensions are generally limited by its weight when outfitted. It may be a portion of the double bottom, a piece of side shell, or part of an engineroom flat.
>
> A "block" is an assembly of two or more units.
>
> A "Package" or "Package Unit" is an assembly of outfit material and/or components. An example may be a pump package which would consist of a pump or pumps and the associated strainers, filters, foundations, piping, gratings, walkways, ladders, electrical controllers, instrumentation, etc. It is generally a complete assembly of all components occupying a particular space on the ship. It may even contain components not related to the assembly by function but related to it by location - such as a salt water line passing through the foundation for a fuel oil package. Since it is in that location, it would be part of the package. The aim is that once that package is landed in place, a minimum of additional work will have to be done in that location to place the systems in operation. Package Units may be landed on unit, on block, or on board, depending on weight considerations and the hull erection sequence.

The driving force in zone outfitting technology is the installat of components at the times and under the conditions that produce lowest overall costs. This sounds very simple. As we progress, will see that “times” also mean “places” or “locations, ” and “conditions” also mean construction status, worker environment, and the end use of the component. This challenge demands very close planning and coordination among the Engineering disciplines and between Engineering and Production. All must clearly understand exactly what is going to be accomplished and how and by whom it will be carried out.

Zone outfitting actually could be applied even if the engineering drawings were prepared using the conventional system approach. This approach would require a set of completed system drawings prior to the start of construction and a staff of production Ehgineers to sort out what should be installed at the different stages of construction. This would not be very cost effective, since the systems would probably not have been detailed to suit this approach, plus a lot of time would be involved keeping track of each component. To gain the maximum advantage, the construction drawings must be subdivided and developed in accordance with the Production Plan for fabricating and outfitting each unit.

Each drawing must contain only that information necessary to do the desired job at the planned time. The designer must also consider the physical progress of the surrounding area at the time of installation. Previous dimensioning techniques of distance above baseline and distance off centerline cannot be used in installing a component, say a pipe run, in a unit that does not contain the centerline or baseline. Dimensioning, therefore, must refer to a fixed point in the unit being worked. It is very important that the drawings reflect the agreed upon construction sequence, since they also control the flow of material. Portions of piping systems, manholes, ladders, reach rods, wireway hangers, etc. may require installation as a particular unit is being constructed, maybe before the unit is complete or before it is painted. The drawing reflects this by specifying when the material or component is installed. This specification is called a pallet code. Each piece of material is pallet coded. The Material Control Section of Production uses the pallet code information to assemble all material to be installed at a particular time and routes it to the exact location for installation. The importance of the pallet code cannot be over emphasized, since it controls the flow of material. In zone outfitting, the flow of material basically controls the cost of the job. GRAPH IN-1 is an example of the Pallet Code System used at Avondale.

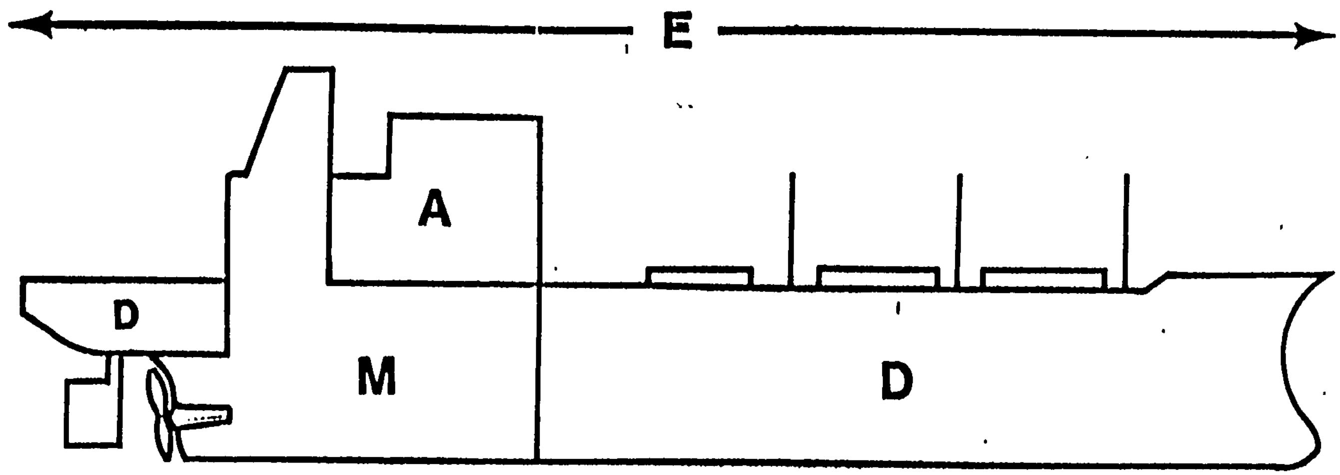
The pallet code is basically an eight-character designation. The first two characters represent a craft labor cost code. The middle three characters specify the unit number for material to be installed on unit, or the zone for material to be installed on board. The sixth and seventh characters are the pallet serial number. The last character in the code indicates the stage of construction at which time the material will be installed. To assist Production in the control of material, each drawing on the page has a tabulation of the pallet codes contained on the drawing. GRAPH IN-2 is an example of this tabulation.

Some reassignment of work in the Engineering Sections was necessary to better equip the Avondale Engineering Department to accomplish zone outfitting; however, there was no major reorganization. The most, significant organizational change was to establish the Package Unit Group in the Mechanical Engineering Section. This group develops complete machinery package units for the machinery space. They detail the equipment foundations, gratings. and handrails, as well as the piping, instrumentation, *etc.* More will be said about this later in the day. IHI consultlants had recommended to Avondale management an engineering organization similar to theirs. GRAPH IN-3 shows the basic engineeing organization utilized by IHI. It consists of four Engineering Groups: Deck, Machinery, Accommodation, and Electric. Such a change was not considered necessary at Avondale, in addition to not being best suited for our present distribution of talents. Functionally, however, our current organization embodies some of these concepts. Examples are as follows:

- The newly established Package Unit Group handles all aspects of the Package Unit design.
- Our Outfitting Section essentially controls the arrangement and routing of all systems in the accommodation areas.
- The Mechanical Section controls the routing of all systems in the machinery space.
- The Hull Section still handles the steel superstructure and machinery space structure, except for the Package Unit foundations and support structure which is handled by the Package Unit Group.
- The output of the Hull Section is the Yard Plans which are used by the Mold Loft to produce the working drawings.

These procedures are very similar *to* the IHI concept.

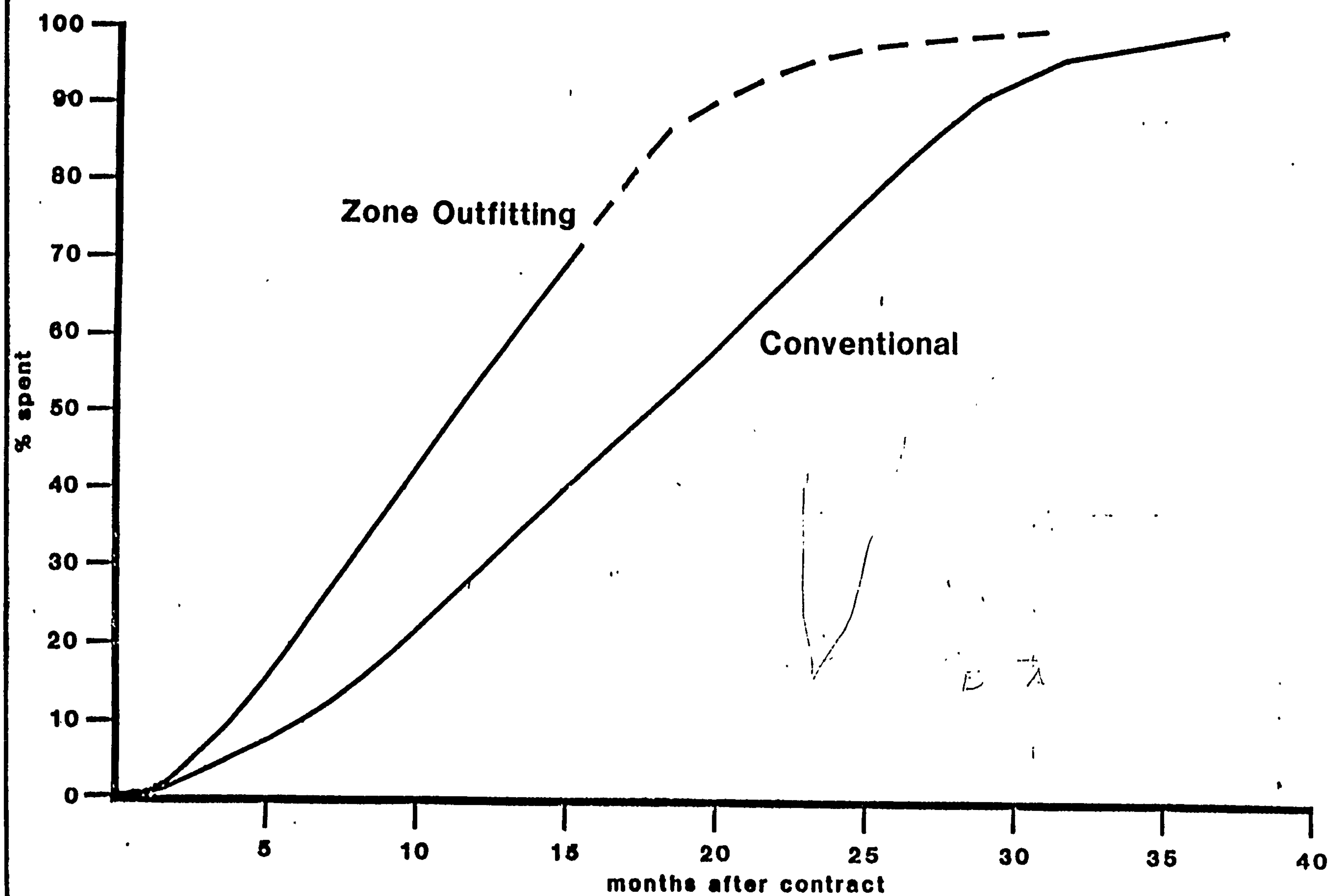
Regardless of the organization or how it is constructed, the most necessary ingredient is effective communication. Good communication 'is important, not only among Engineering personnel but also between the Engineering and Production orgznizations. With the proper level "of discussions involving the working groups of Engineering and Production, the methods and details of the construction can be discussed ahead of time and reflected in the construction drawings. The personnel supervising the preparation of the drawings must be



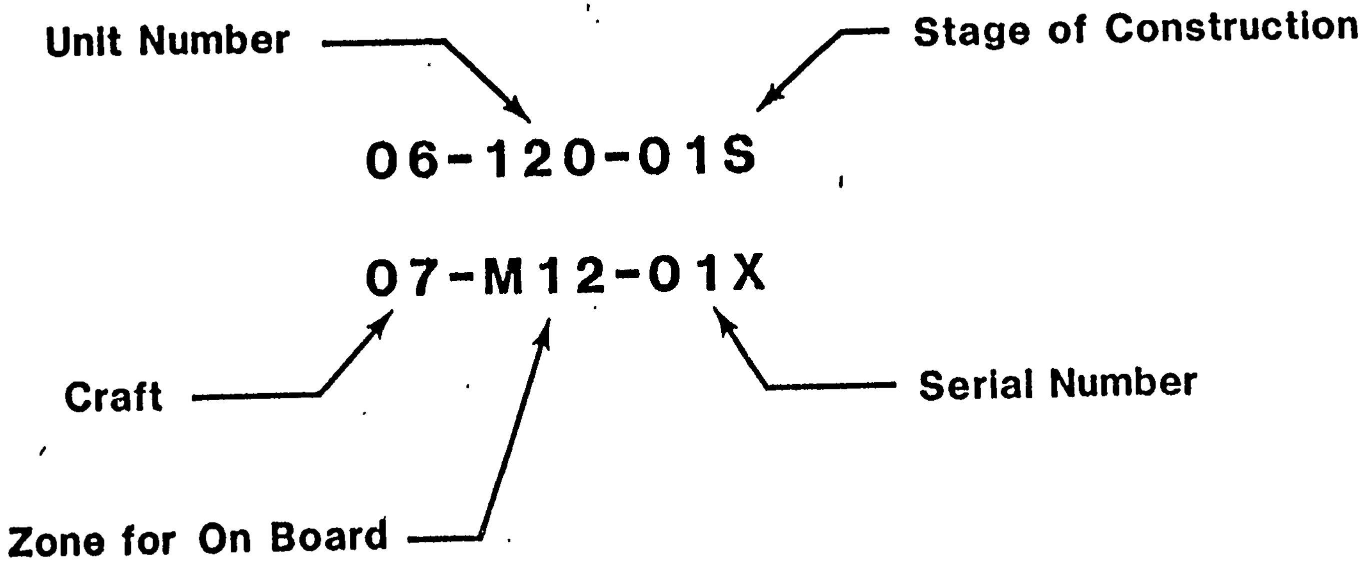
D - Deck
M - Machinery
A - Accommodations
E - Electrical

I H I Organization

IN-3



100
90
80
70
60
50
40
30
20
10
0
% spent
Zone Outfitting
Conventional
5
10
15
20
25
30
35
40
months after contract



Example of Pallet Codes

IN-1

THIS DRAWING CONTAINS MATERIAL WITH THE FOLLOWING PALLET CODES

PALLET CODE	DESCRIPTION
S	DURING SUB ASSEMBLY ....ON UNIT
U	BEFORE TURNING DURING MN ASSY ....ON UNIT
T	AFTER TURNING — PRIOR TO PAINT ....ON UNIT
V	AFTER PAINT — PRIOR TO ERECTION ....ON UNIT
J	AFTER JOINING W/OTHER UNITS — PRIOR TO ERECTION..ON BLOCK
X	BEFORE CLOSING IN ....ON BOARD
Y	EASY ACCESS OR ON OPEN DECK ....ON BOARD
Z	FINAL OUTFITTING, PILFERABLES, SPARE PARTS, LOOSE ITEMS, ETC. ....ON BOARD
1R	MATERIAL TO BE ROUTED TO RACK ASSEMBLY AREA
1P	MATERIAL TO BE ROUTED TO PACKAGE UNIT SHOP
1	MATERIAL TO BE ROUTED TO PIPE SHOP
2	MATERIAL TO BE ROUTED TO FRP PIPE FABRICATION AREA

aware of how the work will be accomplished. They can then insure that the engineering drawing is of the greatest assistance to Production.

Zone outfitting technology has not only required a change in the manner in which information is presented to Production, it has also changed the amount of information supplied. Engineering is much more deeply involved in the methods and sequence of construction, since this rationale must be reflected in the drawings. The control of material must also be reflected in the drawings. In addition, certain work previously left for field accomplishment is now reflected on the drawings. An example is the detailing of small pipe 3/4" to 2", which was previously field run.

The preparing of drawings on a unit basis has greatly increased the number of drawings. The total amount of information supplied is greater because of the added scope, but by no means is it in the same ratio as the increased number of drawings. Each drawing covers a smaller portion of the ship, as compared to the conventional method. There are only a few very long "H" size drawings. Most of the drawings are of the booklet type. If we were to count the number of drawings in the plan schedules for two similar ships at Avondale, the zone outfitted ship would have about twice as many drawings. The major reason for this is in the method of presenting the piping work. There are about three times as many piping plans for the zone-outfitted ship. This is because a piping arrangement drawing which may apply to two units is accompanied by two pipe detail drawings and two lists of materials, one each for each unit. Previously, the arrangement drawing would have included more units and would be accomplished by only one pipe detail booklet and one list of material. This is necessary, since the pipe is fabricated by unit, then stored by pallet code to await installation. The list of material must be by unit to suit the pipe fabrication sequence.

Under the conventional system approach, a particular drawing had a Production required date based on when Production intended to start work on that system. Production work on the entire system may have spanned a considerable length of timne. Under zone outfitting, the same amount of production work will be portrayed on many drawings. Each drawing, however, has a much more critical issue date since work on that portion of the system is closely knit into the pre-outfitting plan. This means that Engineering must very effectively plan the start, the progress, and the issue of all drawings and the support activities necessary to provide the information needed for developing these drawings. The Engineering Planning and Scheduling Section has been expanded to effectively handle this task, and a detailed description of its operation is scheduled for later today.

The use of zone outfitting at Avondale, thus far, has increased the scope of the Engineering job and consequently the engineering costs. However, it is expected that this increase will be more than offset by savings in manhours and time in Production. This first use of zone outfitting in Engineering involved a considerable learning period. Many operational procedures were established only through pains-taking investigation and some trial and error. These costs will not be repetitive. The next zone outfitting engineering job will benefit greatly from our experience here. As we improve these methods and as all concerned become more familiar with the system, we expect that less information will be required from Engineering. It is also intended that many of the methods and details developed for this first job will become a standard on future jobs, thus reducing the engineering costs. It is anticipated that, as methods are standardized and improved over several jobs, the engineering costs may actually become equal to those under conventional methods. The savings in Production will also improve as their techniques are further refined.

The most severe impact on Engineering for zone outfitting has been the schedule requirements for issuing drawings. These requirements demanded quick resolution of problem ares, prompt and complete response from vendors for resolving interfaces and very close coordination among the Engineering disciplines and between Engineering and Production Planning. Many new approaches, both in fabrication and in presentation of engineering information, had to be resolved with the production crafts during the development of the drawings. Much of this will not be necessary on future jobs. These demands were met by a proper concentration of engineering talent on the job from its very beginning.

GRAPH IN-4 shows the percentage of spending against time for a current zone-outfitted job compared to a composite curve of several previous jobs. Please note the steep slope of the current job about 5.3% a month as compared to about 3.8% a month on previous jobs. This means that at keel laying the engineering is about six to seven months ahead of where it would have been following the previous system.

The most challenging aspect of zone outfitting for Engineering is the start of the engineering effort. The manning build-up period must be short. Once the necessary manning to meet the schedule is reached, it must be maintained as necessary and the progress monitored closely. Of course, we all know that manning alone is not the total answer. Productivity has to be achieved. False starts and reverses must be avoided. Manning cannot want for direction, information, or decisions. The most important pre-requisite to a good start is a complete, correct, and well defined contract package.

Mr. Nierenberg will speak to this subject.

DESIGN ENGINEERING FOR ZONE OUTFITTING
AVONDALE SHIPYARDS, INC.

PRE-CONTRACT EFFORT AND KEY PLANS

DESIGN ENGINEERING FOR ZONE OUTFITTING
PRE-CONTRACT EFFORT AND KEY PLANS

I. PRE-CONTRACT EFFORT

The concept of a pre-contract effort in unit and zone outfitting methods of shipbuilding is perhaps the ultimate recognition of the many differences between Japanese and U.S. shipbuilding philosophies and working environments and an attempt to overcome these differences to provide the necessary information to implement this technology.

The majority of commercial ship contracts in Japan rely heavily upon previous ship designs, industry standardization and gradual implementation of new technology, thereby resulting in a well defined ship design at time of contract. In contrast to this, the U.S. shipbuilding market offers only a limited number of new construction opportunitites for widely varying types of vessels, each of which generally incorporate quantum jumps in technology over previous designs, making the effective use of previous design details limited at best. The method of ship contracting in the U.S., the issue of design responsibility between shipowner and shipbuilder, and the role of independent naval architecture firms all contribute to uncertainty in many key aspects of a ship design during the proposal and contract negotiation stage.

These uncertainties in a basic vessel design generally have two (2) pronounced implications to the shipyard. The first issue is a scaricity of complete and workable details of the ship design which makes the preparation of accurate cost estimates risky. The second major issue, although not totally independent of the first, is the lack of sufficient technical information at the time of contract to enable rapid engineering development to proceed as necessary to accomplish the goals of unit and zone outfitting.

At this time, is is extremely important to recognize the overall scheduling concept associated with unit and zone outfitting to understand the combined impact on the engineering scheduling effort. Firstly, it is expected that the total construction period from keel laying to delivery for a unit outfitted ship, as compared to a conventionally constructed vessel of comparable configuration, will be significantly reduced enabling the shipyard to offer a quicker delivery with the vessel cost less subject to added escalation. This savings in time is generally applied to the total contract time with theoretically no impact on the engineering lead time. However, the system of unit outfitting and other production techniques also dictate that a far greater stage of overall work completion be achieved at time of keel laying, necessitating the start of pre-fabrication several months further in advance of the keel laying date than in conventional construction methods, resulting in a shortened engineering lead time. The unit outfitting methodology also requires that a far greater level of engineering be complete at the start of pre-fabrication such that all possible work is accomplished on-unit.

We have adopted the phrase, "engineering essentially complete" to illustrate our overall scheduling goal at time of pre-fabrication. Typically, we have seen the percentage of total engineering manhours spent at time of pre-fabrication increase from approximately 50% in a conventional construction system to approaching 75% in a fully unit outfitted concept.

Additionally, in order to support unit outfitting requirements, the quantity of engineering information required has grown substantially, adding to the burden of time. The added levels of engineering for each discipline will be covered throughout this Presentation.

The net effect of the overall vessel scheduling is a far greater level of engineering effort to be accomplished in a far shorter period of time. This fact is clearly illustrated on Graphs No. PC-1 and No. PC-2.

In order to provide the needed engineering response in light of a doubled level of intensity, it is imperative that a pre-contract level of effort be expended to properly position the engineering disciplines for this tremendous post contract effort. The exact objectives of the pre-contract effort will obviously vary from program to program and will be decided by management in consideration of the business environment at that time.

A prime consideration in the planning of the engineering effort must always take into account that with a level of effort twice that of a conventional contract, every after contract uncer-tainty, design change, etc. has twice the impact due to the rapid pace at which the engineering and installation details are being developed. It must be remembered that the pre-contract effort is virtually always funded at the shipbuilder's expense and, therefore, the effort must be well managed and be as productive as possible.

Simply stated, the objectives of the pre-contract effort are to ensure design parameters, contract requirements, construction methods, scheduling and long lead time material needs are all well defined at time of contract such that the intense engineering effort can begin. As will be discussed later, the engineering effort immediately after contract is considered the "key plan" stage, at which time all facets of the engineering design are to be finalized to enable umimpeded development during the yard plan stage. (See Graph No. PC-3.)

The overall effectiveness of the pre-contract period is largely controlled by the method of ship contracting and the committment of the vessel's owner in participating in this endeavor with the shipyard. In competitive bidding situations, whether for private or government contracts, relatively little dialogue will be possible with the owner, and the shipyard's effort must be adjusted accordingly. On the other hand, negotiated contracts with owners who have in-house technical staffs can result in pre-contract efforts that resolve numerous design details and pave the way for effective design development after contract.

In some respects the listing of pre-contract objectives may seem routine, but the demands of the unit outfitting system require extremely close cooperation among all facets of shipyard operations and the early involvement of Production Planning in the design effort. As a few examples of the interelationship which exists, consider that in the unit outfitting system a drawing listing cannot even be compiled by Engineering until such time as the hull unit construction arrangement is defined, or the fact that the material need date for the same piece of equipment can vary as follows, depending on construction method:

CONSTRUCTION METHOD	**MATERIAL NEED (MONTHS)**
On Board	
On Unit	17
Package Unit	12

In summary, the unit outfitting methods offer a powerful tool for ship construction, but simultaneously place a substantially increased burden on the engineering and planning activities. In order to meet the schedules imposed, it is imperative that a clear and concise understanding of the task at hand be understood at time of contract, including the sizeable expenditure of company resources in anticipation of a contract to accomplish the necessary state of preparedness.

II. KEY PLANS

The concept of Key Plans is really not a new idea to U.S. shipbuilders, as the designation of the vessels' principal design drawings has been referred to as Key Plan by the U.S. Maritime Administration for many years. However, in-unit and zone outfitting methodology, the scheduling of key plans becomes of critical importance as these drawings are intended to depict all aspects of the vessel design which are necessary for detail drawing development during the yard plan stage.

For a typical commercial ship construction program with a twenty-eight (28) month construction period as shown on Graph No. PC-1, the engineering lead time period is twelve (12) months prior to Pre-fabrication. This twelve (12) month period would generally be divided into a five (5) month key plan stage and a seven (7) month yard plan stage. There are obviously overlaps in that time frame with many of the key plans scheduled for completion within the first month or so after the contract, and the five (5) month period representing the completion of all the so designated key plans.

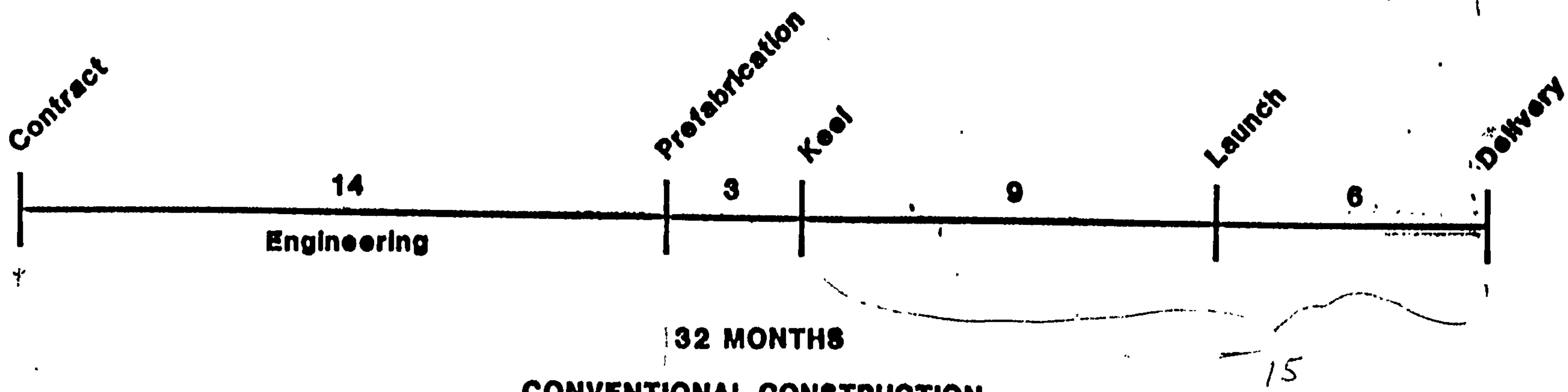
The determination of which drawings are to be identified key plans is done during the initial preparation of a drawing list and is the basis for the first drawing scheduling effort for any engineering section. In general, any drawing which depicts design details of the vessel in way of arrangements or system configuration or is necessary for the procurement of long lead time material will be designated as a key plan. Each Engineering Section will discuss additional aspects of these drawings during their presentation, and the following Graphs No. KP-1 through No. KP-8 illustrate the designation of key plans on a recent product carrier program.

There is one very important concept of key plans that everyone should be aware of with the necessary steps taken to avoid that pitfall, that being too rigid an interpretation of drawing completion during the key plan period. If drawings are configured in a more or less conventional fashion, many key plans will require information which is not available as yet due to further vendor information or additional development work required. This must not be allowed to hold up the distribution of the design information aspects contained on the key plans, as this information has been integrated into detailed schedules and is needed by other sections to start their effort. This potential problem can be overcome by the use of separate design sketches which later form the basis of a yard plan, or the creation of additional drawings whose scope is limited to the design details.

A good example of this is the area of compartment and arrangement drawings, where on commercial contracts ASI does not produce a final compartment and access drawing, but rather a complete general arrangement drawing. To satisfy the needs of the key plan period, sketches called “compartment and access studies,” with information limited to that needed by others at that time, were created. These same drawings would be ultimately expanded to become the general arrangement drawings to be prepared during the yard plan period. In other areas, such as piping diagrams where virtually all the data is needed early by other segments of the shipyard, the drawing is completed to the maximum extent feasible with outstanding vendor data or other information, which is not truly-needed by others at that time, held in reservation. The important concept is that there must be excellent communication during this design period with no one waiting to issue a final perfect plan at the detriment of withholding valuable data others require.

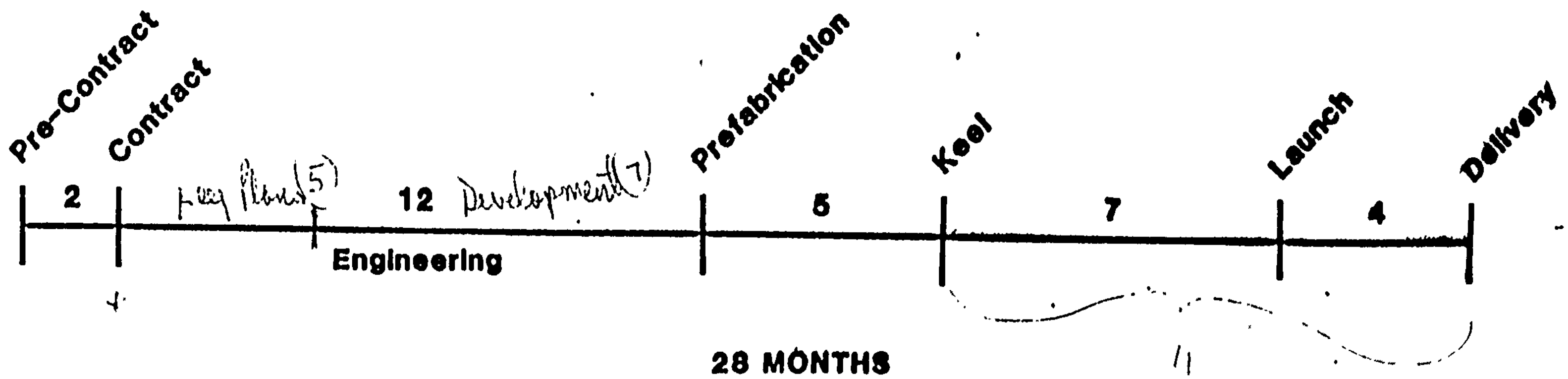
OVERALL SCHEDULING IMPACT

UNIT OUTFITTING vs CONVENTIONAL CONSTRUCTION



32 MONTHS

CONVENTIONAL CONSTRUCTION



28 MONTHS

UNIT OUTFITTING

PC-1

INTENSITY OF ENGINEERING EFFORT

CONVENTIONAL CONSTRUCTION

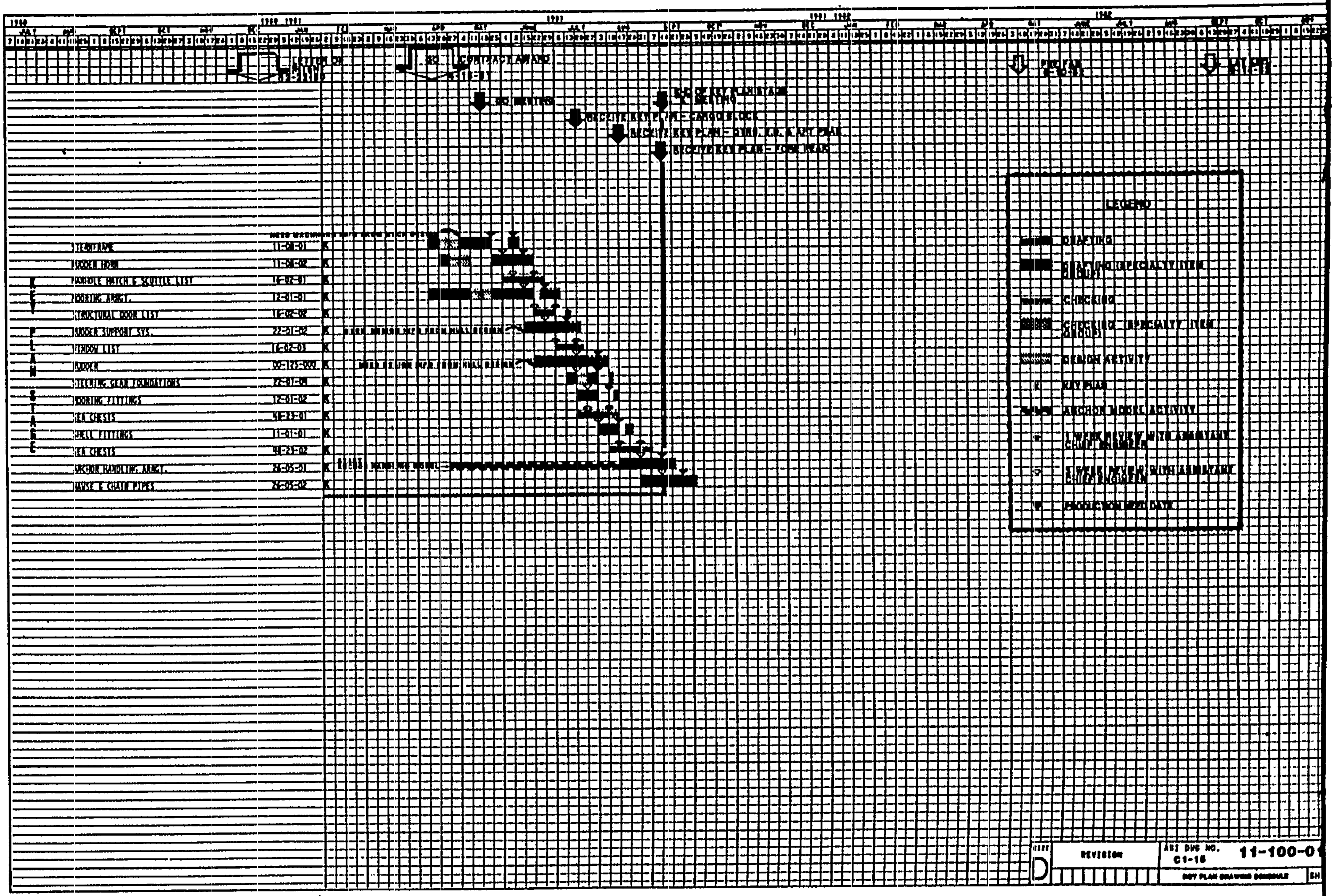
- Total Engineering Manhours - - - - - - - - - - - - -350,000
- Percent Complete At Pre-Fabrication - - - - - - - - 60 %
- Months From Contract To Pre-Fabrication- - - - - - 14
- Manhours Per Month (avg) Prior To Pre-Fabrication - 15,000

UNIT OUTFITTING

- Total Engineering Manhours - - - - - - - - - - - - -500,000
- Percent Complete At Pre-Fabrication - - - - - - - - 80 %
- Months From Contract To Pre-Fabrication- - - - - 12
- Manhours Per Month (avg) Prior To Pre-Fabrication - 33,333

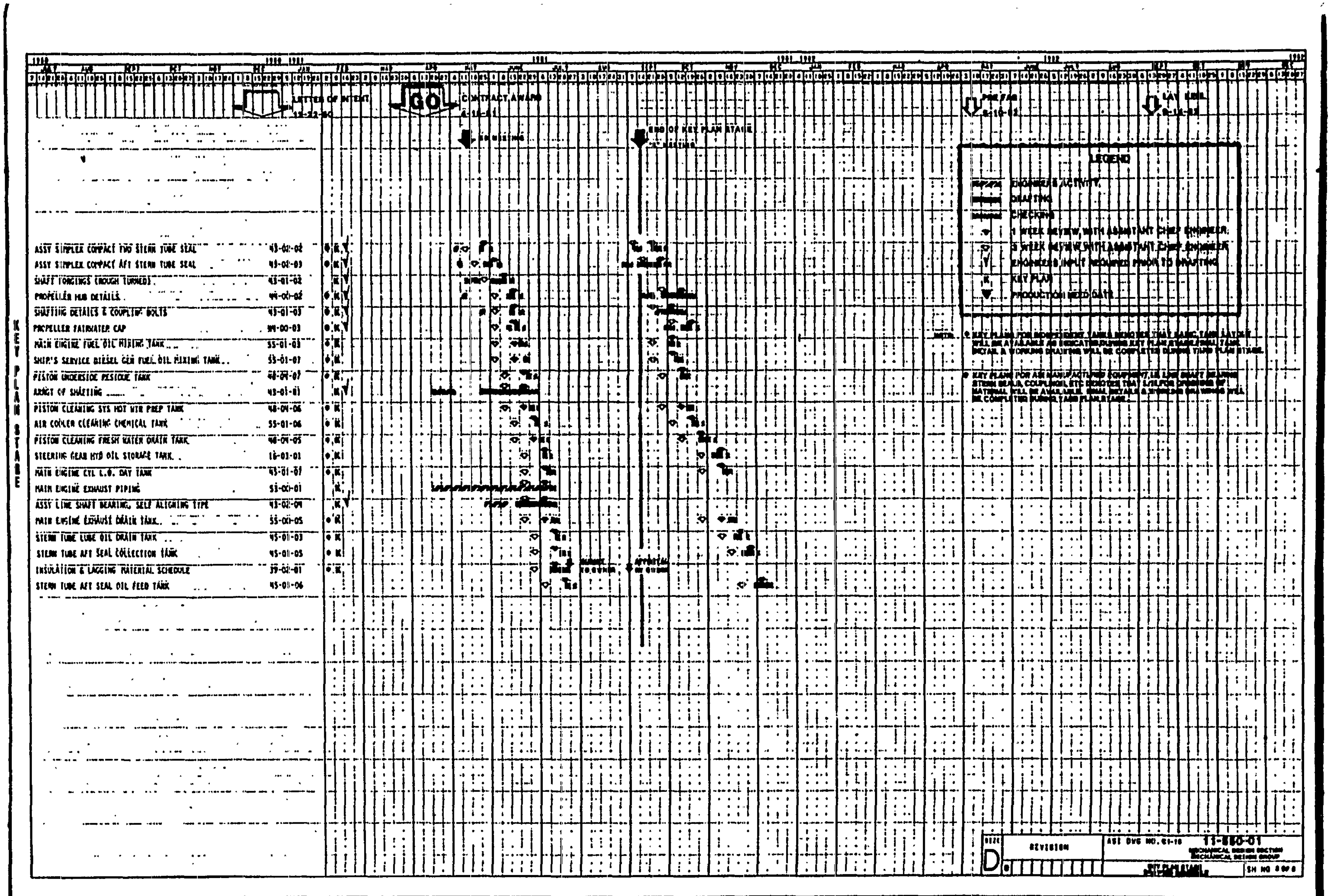
SUMMARY

- Engineering Intensity More Than Twice As Great In Unit Outfitting



1980
1980 1981
1981
1981 1982
1982
CONTRACT AWARD
RECEIVE KEY PLAN - CARGO BLOCK
RECEIVE KEY PLAN - FORE PEAK
STERNFRAME
RUDDER HORN
MANHOLE HATCH & SCUTTLE LIST
MOORING ARRGT.
STRUCTURAL DOOR LIST
RUDDER SUPPORT SYS.
WINDOW LIST
RUDDER
STEERING GEAR FOUNDATIONS
MOORING FITTINGS
SEA CHESTS
SHELL FITTINGS
SEA CHESTS
ANCHOR HANDLING ARRGT.
HAWSE & CHAIN PIPES
11-08-01
11-08-02
16-02-01
12-01-01
16-02-02
22-01-02
16-02-03
00-125-000
22-01-04
12-01-02
48-23-01
11-01-01
48-23-02
24-05-01
24-05-02
KEY PLAN STAGE
LEGEND
CHECKING
KEY PLAN
REVISION
C1-16
11-100-0
KEY PLAN DRAWING SCHEDULE

KP-2


LETTER OF INTENT
GO
CONTRACT AWARD
END OF KEY PLAN STAGE
KEY PLAN STAGE
ASSY SIMPLEX COMPACT TWO STERN TUBE SEAL 43-02-02
ASSY SIMPLEX COMPACT AFT STERN TUBE SEAL 43-02-03
SHAFT FORGINGS (ROUGH TURNED) 43-01-02
PROPELLER HUB DETAILS 44-00-02
SHAFTING DETAILS & COUPLING BOLTS 43-01-03
PROPELLER FAIRWATER CAP 44-00-03
MAIN ENGINE FUEL OIL MIXING TANK 55-01-03
SHIP'S SERVICE DIESEL GEN FUEL OIL MIXING TANK 55-01-07
PISTON UNDERSIDE RESIDUE TANK 48-04-07
ARRGT OF SHAFTING 43-01-01
PISTON CLEANING SYS HOT WTR PREP TANK 48-04-06
AIR COOLER CLEANING CHEMICAL TANK 55-01-06
PISTON CLEANING FRESH WATER DRAIN TANK 48-04-05
STEERING GEAR HYD OIL STORAGE TANK 16-03-01
MAIN ENGINE CYL L.O. DAY TANK 45-01-07
MAIN ENGINE EXHAUST PIPING 53-00-01
ASSY LINE SHAFT BEARING, SELF ALIGNING TYPE 43-02-04
MAIN ENGINE EXHAUST DRAIN TANK 55-00-05
STERN TUBE LUBE OIL DRAIN TANK 45-01-03
STERN TUBE AFT SEAL COLLECTION TANK 45-01-05
INSULATION & LAGGING MATERIAL SCHEDULE 39-02-01
STERN TUBE AFT SEAL OIL FEED TANK 45-01-06
LEGEND
ENGINEER'S ACTIVITY
DRAFTING
CHECKING
1 WEEK REVIEW WITH ASSISTANT CHIEF ENGINEER
ENGINEERS INPUT REQUIRED PRIOR TO DRAFTING
KEY PLAN
PRODUCTION NEED DATE
REVISION
11-860-01
D

OBJECTIVES OF PRE-CONTRACT EFFORT

CONSTRUCTION & SCHEDULING

- Hull Unit Construction Arrangement
- Outfitting Zone Assignment
- Material Need Dates
- Package Unit Determination
- Drawing List & Scheduling
- Key Plan Determination & Scheduling
- Manpower Planning

how [illegible]

MATERIAL REQUIREMENTS

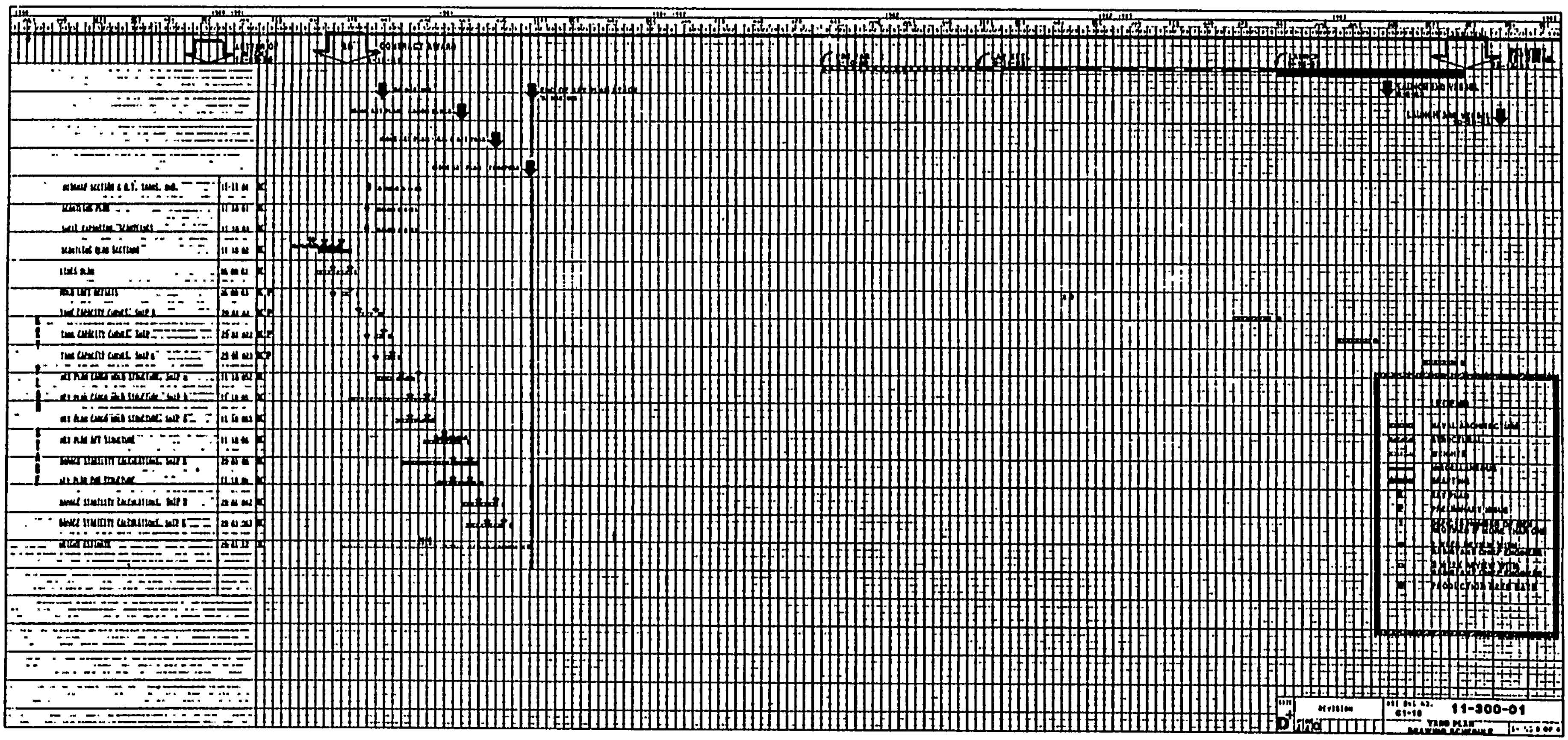
- Purchasing Department Terms & Conditions
- Purchase Specifications For Major Equipment

CONTRACT PACKAGE

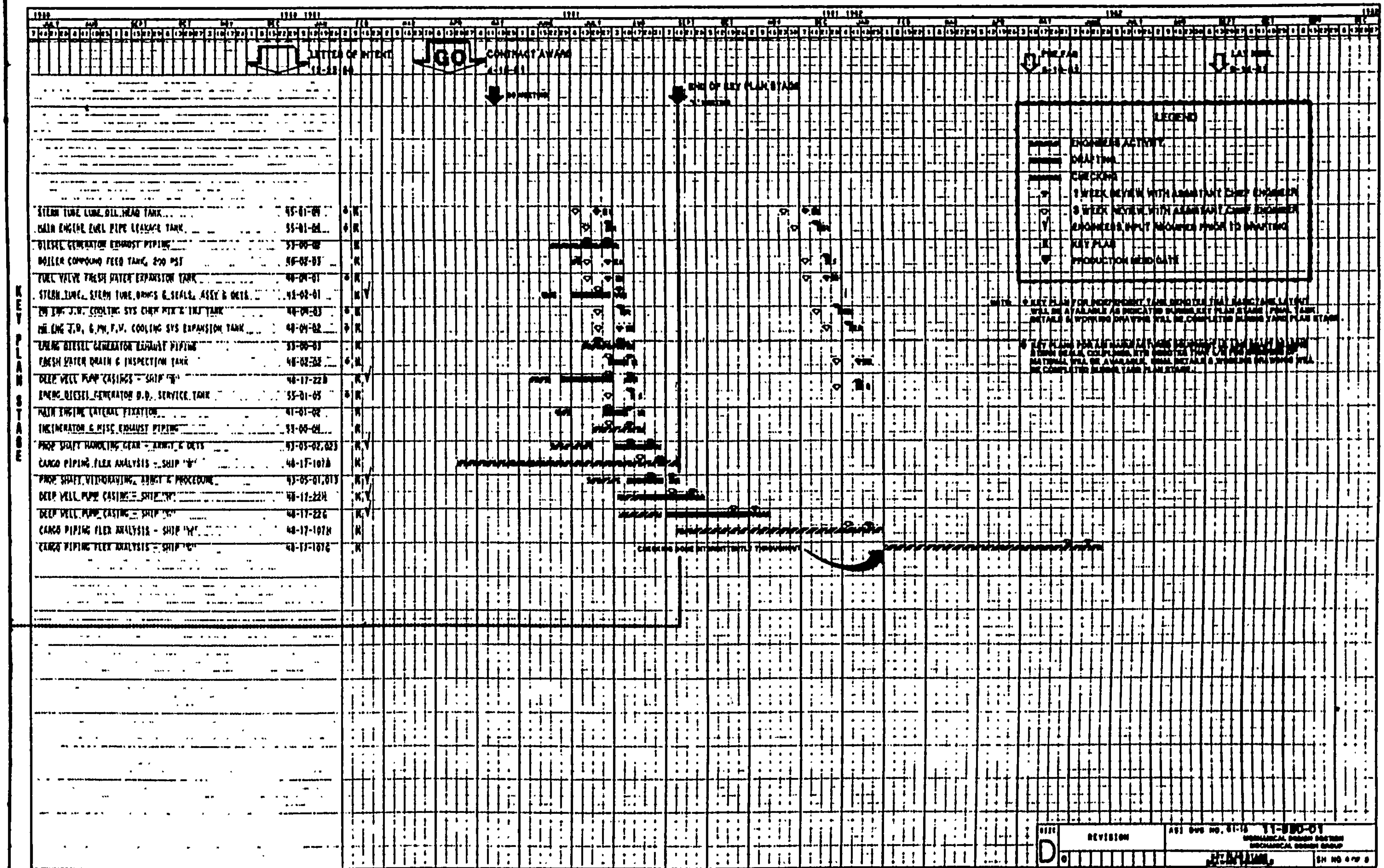
- Contract Specification
- Complete Contract Drawing Package
  - Piping Diagrams
  - General Arrangements
  - Structural Drawings
  - Electrical One-line
- Naval Architecture Calculations
  - Longitudinal Strength
  - Intact & Damaged Stability
  - Weight Estimate
  - Lines Plan

ADDED ENGINEERING EFFORT

- Model Testing
- Initial Regulatory Body Review
- Lines Fairing
- Ventilation System Development

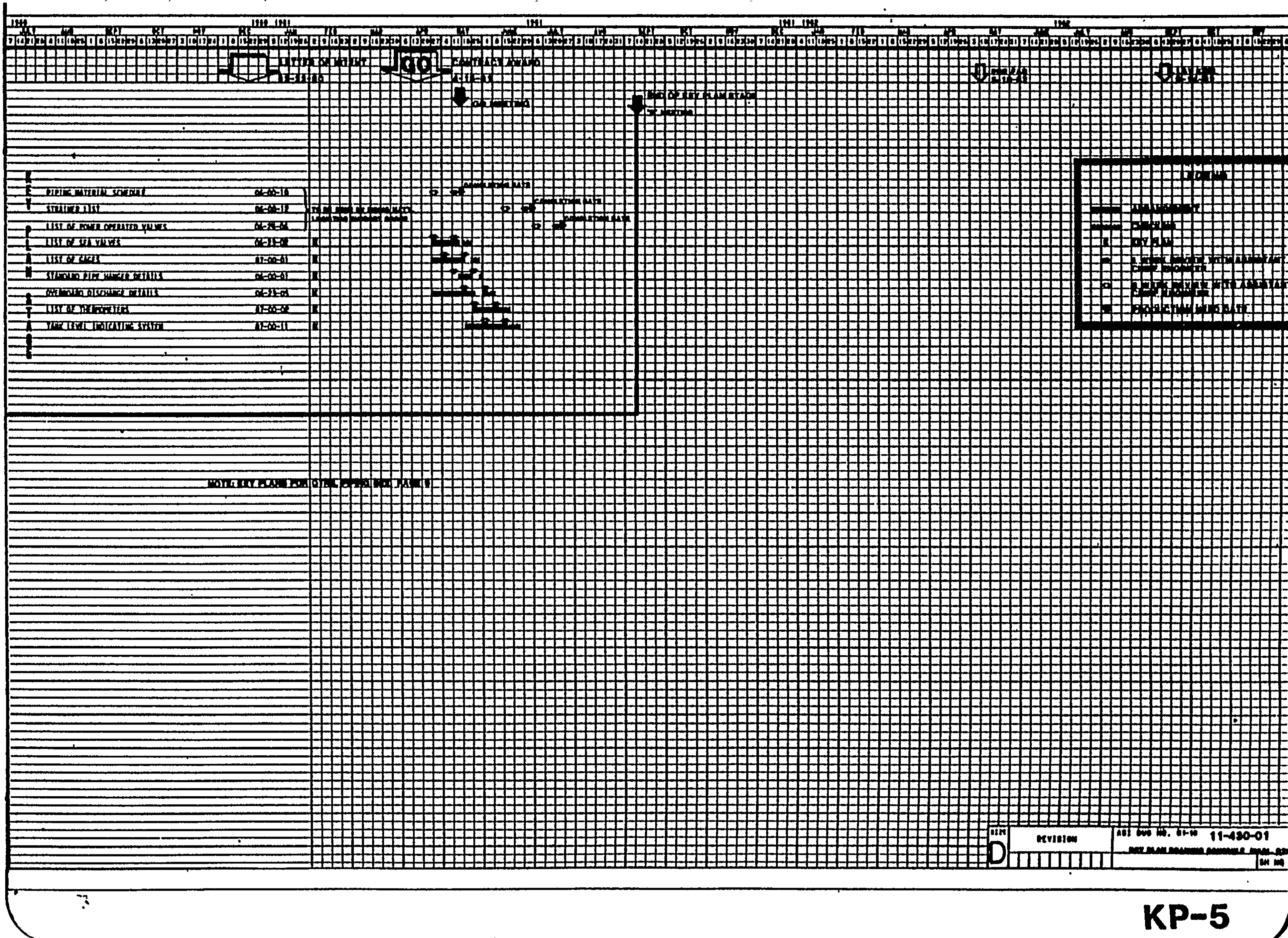


KP-1



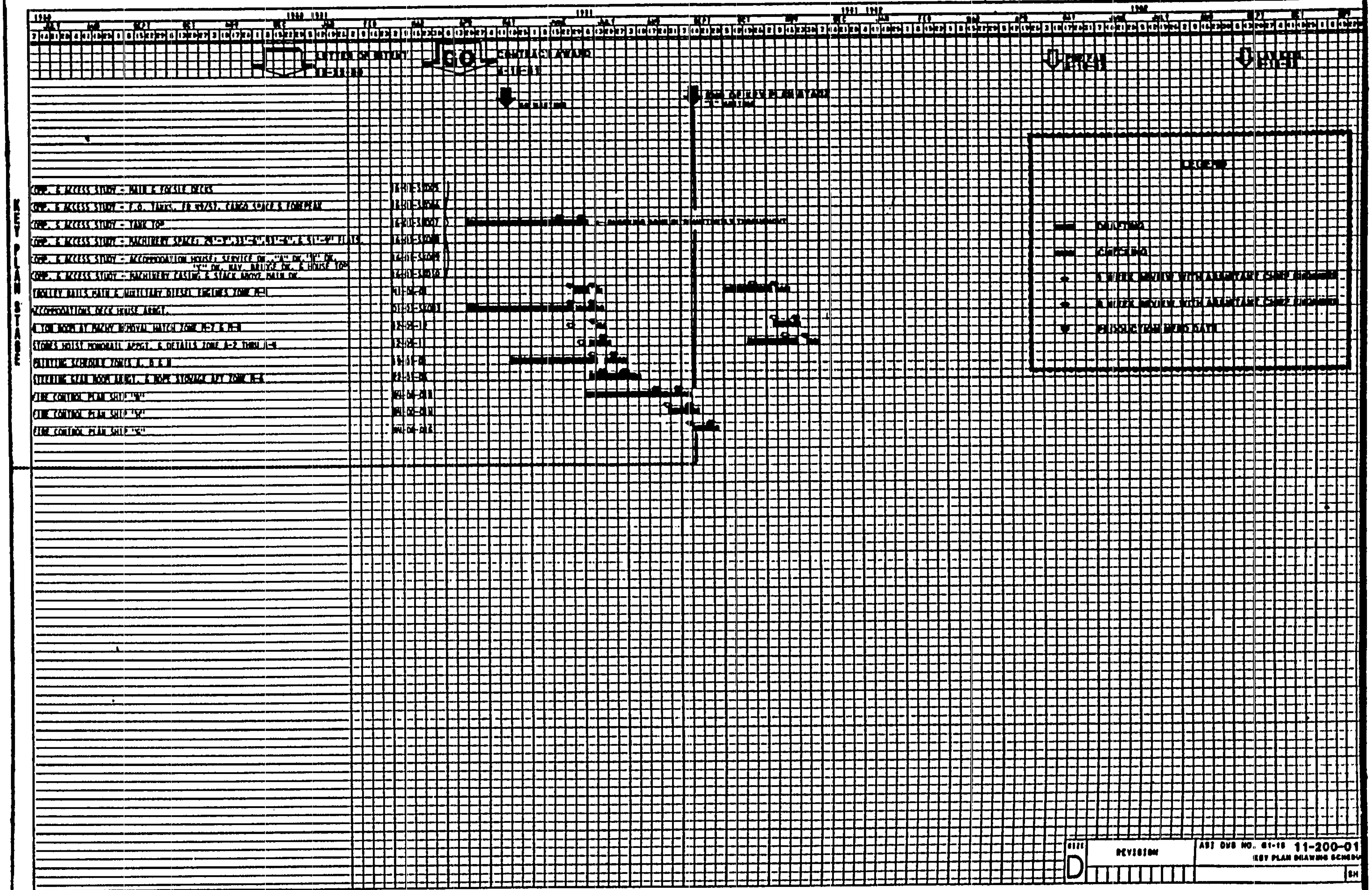
LETTER OF INTENT
GO
CONTRACT AWARD
END OF KEY PLAN STAGE
KEY PLAN STAGE
STERN TUBE LUBE OIL HEAD TANK
MAIN ENGINE FUEL PIPE LEAKAGE TANK
DIESEL GENERATOR EXHAUST PIPING
BOILER COMPOUND FEED TANK, 200 PSI
FUEL VALVE FRESH WATER EXPANSION TANK
STERN TUBE, STERN TUBE BRGS & SEALS, ASSY & DETS.
MAIN ENGINE LATERAL FIXATION
INCINERATOR & MISC EXHAUST PIPING
CARGO PIPING FLEX ANALYSIS - SHIP "H"
CARGO PIPING FLEX ANALYSIS - SHIP "G"
LEGEND
ENGINEERS ACTIVITY
DRAFTING
CHECKING
1 WEEK REVIEW WITH ASSISTANT CHIEF ENGINEER
3 WEEK REVIEW WITH ASSISTANT CHIEF ENGINEER
ENGINEERS INPUT REQUIRED PRIOR TO DRAFTING
KEY PLAN
PRODUCTION NEED DATE
REVISION

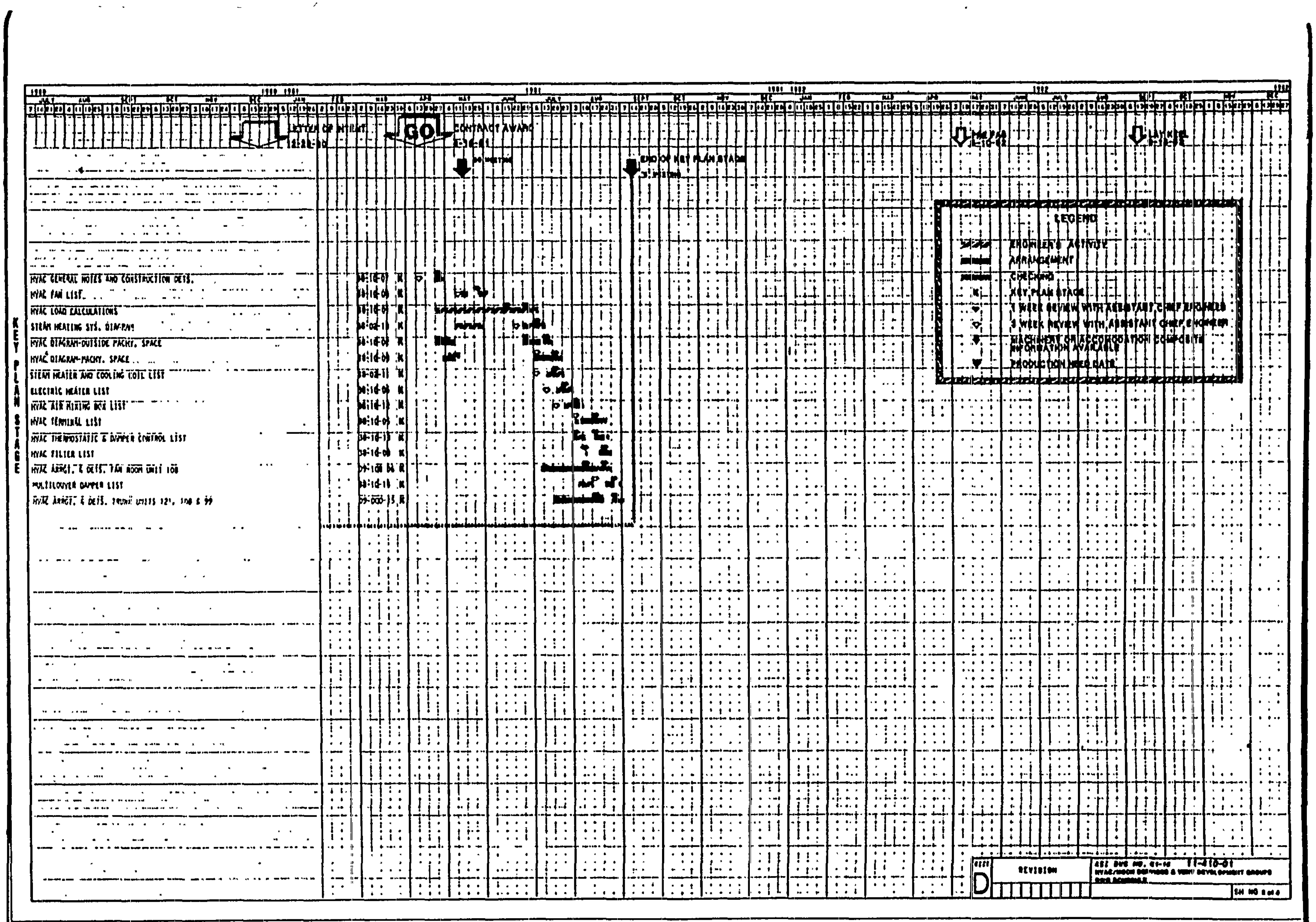
KP-4



LETTER OF INTENT
GO
CONTRACT AWARD
COMPLETION DATE
KEY PLAN
PIPING MATERIAL SCHEDULE
06-00-10
STRAINER LIST
06-00-12
LIST OF POWER OPERATED VALVES
06-20-06
LIST OF SEA VALVES
LIST OF GAGES
07-00-01
STANDARD PIPE HANGER DETAILS
06-00-01
OVERBOARD DISCHARGE DETAILS
06-23-05
LIST OF THERMOMETERS
07-00-02
TANK LEVEL INDICATING SYSTEM
07-00-11
ARRANGEMENT
CHECKING
KEY PLAN
PRODUCTION NEED DATE
REVISION
11-430-01

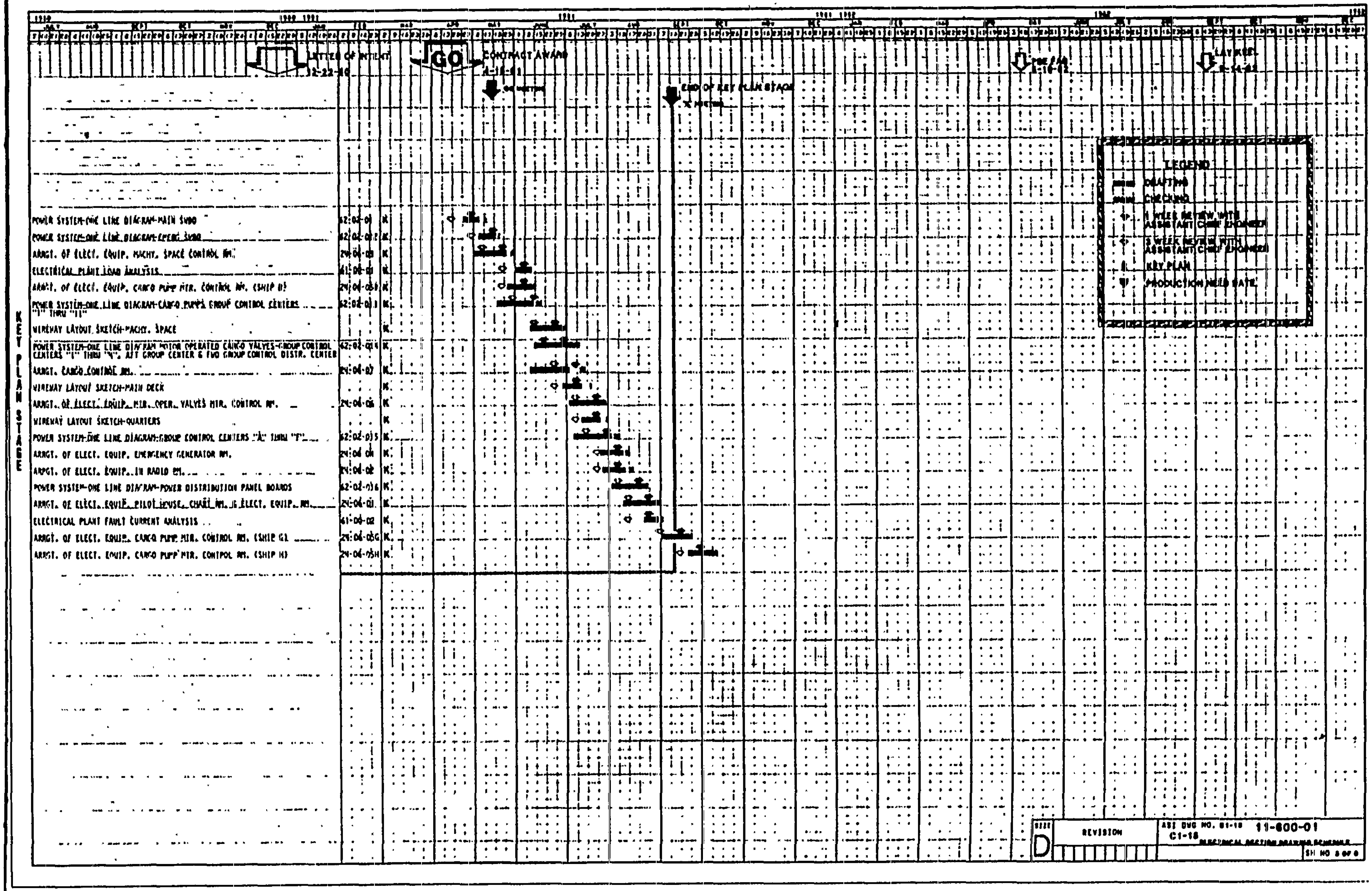
KP-5


KEY PLAN STAGE
LETTER OF INTENT
CONTRACT AWARD
COMP. & ACCESS STUDY - MAIN & FOCSLE DECKS
COMP. & ACCESS STUDY - TANK TOP
ACCOMMODATIONS DECK HOUSE ARRGT.
STORES HOIST MONORAIL ARRGT. & DETAILS ZONE A-2 THRU A-4
FIRE CONTROL PLAN SHIP "X"
LEGEND
REVISION
D
11-200-01
KEY PLAN DRAWING SCHEDU



GO
LETTER OF INTENT
CONTRACT AWARD
END OF KEY PLAN STAGE
KEY PLAN STAGE
HVAC GENERAL NOTES AND CONSTRUCTION DETS.
HVAC FAN LIST
HVAC LOAD CALCULATIONS
STEAM HEATING SYS. DIAGRAM
HVAC DIAGRAM-OUTSIDE MACHY. SPACE
HVAC DIAGRAM-MACHY. SPACE
STEAM HEATER AND COOLING COIL LIST
ELECTRIC HEATER LIST
HVAC AIR MIXING BOX LIST
HVAC TERMINAL LIST
HVAC THERMOSTATIC & DAMPER CONTROL LIST
HVAC FILTER LIST
HVAC ARRGT. & DETS. FAN ROOM UNIT 108
MULTILOUVER DAMPER LIST
HVAC ARRGT. & DETS. TRUNK UNITS 121, 108 & 99
LEGEND
ARRANGEMENT
CHECKING
KEY PLAN STAGE
PRODUCTION NEED DATE
REVISION
D

KP-7



LETTER OF INTENT
GO
CONTRACT AWARD
END OF KEY PLAN STAGE
LEGEND
DRAFTING
CHECKING
KEY PLAN
PRODUCTION NEED DATE
KEY PLAN STAGE
POWER SYSTEM-ONE LINE DIAGRAM-MAIN SWBD 62-02-01 K
POWER SYSTEM-ONE LINE DIAGRAM-EMERG SWBD 62-02-012 K
ARRGT. OF ELECT. EQUIP. MACHY. SPACE CONTROL RM. 24-04-03 K
ELECTRICAL PLANT LOAD ANALYSIS 61-04-01 K
ARRGT. OF ELECT. EQUIP. CARGO PUMP MTR. CONTROL RM. (SHIP B) K
POWER SYSTEM-ONE LINE DIAGRAM-CARGO PUMPS GROUP CONTROL CENTERS "I" THRU "II" 62-02-013 K
WIREWAY LAYOUT SKETCH-MACHY. SPACE K
POWER SYSTEM-ONE LINE DIAGRAM MOTOR OPERATED CARGO VALVES-GROUP CONTROL CENTERS "I" THRU "N", AFT GROUP CENTER & FWD GROUP CONTROL DISTR. CENTER 62-02-014 K
ARRGT. CARGO CONTROL RM. 24-04-07 K
WIREWAY LAYOUT SKETCH-MAIN DECK K
ARRGT. OF ELECT. EQUIP. MTR. OPER. VALVES MTR. CONTROL RM. 24-04-06 K
WIREWAY LAYOUT SKETCH-QUARTERS K
POWER SYSTEM-ONE LINE DIAGRAM-GROUP CONTROL CENTERS "A" THRU "F" 62-02-015 K
ARRGT. OF ELECT. EQUIP. EMERGENCY GENERATOR RM. 24-04-04 K
ARRGT. OF ELECT. EQUIP. IN RADIO RM. 24-04-02 K
POWER SYSTEM-ONE LINE DIAGRAM-POWER DISTRIBUTION PANEL BOARDS 62-02-016 K
ARRGT. OF ELECT. EQUIP. PILOT HOUSE, CHART RM. & ELECT. EQUIP. RM. 24-04-01 K
ELECTRICAL PLANT FAULT CURRENT ANALYSIS 61-04-02 K
ARRGT. OF ELECT. EQUIP. CARGO PUMP MTR. CONTROL RM. (SHIP G) 24-04-05G K
ARRGT. OF ELECT. EQUIP. CARGO PUMP MTR. CONTROL RM. (SHIP H) 24-04-05H K
REVISION
D
11-600-01

KP-8

DESIGN ENGINEERING FOR ZONE OUTFITTING
AVONDALE SHIPYARDS, INC.

HULL TECHNICAL AND DESIGN SECTION

DESIGN ENGINEERING FOR ZONE OUTFITTING
HULL TECHNICAL AND DESIGN SECTION

1. INTRODUCTION

The following is an account of the impact that the introduction of zone outfitting has had on the Avondale Hull Technical and Design Section, which will be referred to here as the Design Section. It should be noted that this report will address zone outfitting technology versus the “conventional” technology of shipbuilding. The term “conventional shipbuilding” is simply the system that Avondale used prior to the introduction of the IHI system.

The Design Section is composed of naval architects, civil engineers, computer programmers, weight programmers and drafting support personnel. The responsibility delegated to the Design Section under the conventional shipbuilding system is the design and preparation of midship sections and associated scantling plans, fairing of lines, naval architectural calculations and drawings, weight estimates and support functions for other sections on an “as-needed” basis. These responsibilities are common throughout the shipbuilding industry and generally must be the very first task accomplished. Although early completion of all engineering functions is desirable under any system of shipbuilding, one of the main features of zone outfitting technology is to have all major engineering efforts completed by a pre-determined accelerated date which corresponds to the start of prefab by Production.

The main impact of zone outfitting technology on the Design Section has been to add several new responsibilities. Some of these functions are completely new to the shipbuilding scheme, while some are functions that were the responsibility of other departments under the conventional system. These new responsibilities are, as will be seen later, such that they must be finished very early so that the accelerated completion date can be met by all Engineering Departments. These new responsibilities are:

- Development of Structural Key Plans
- Creation and Maintenance of the Data Base
- Review of Unit Drawings
- Production/Engineering Liaison

A) DEVELOPMENT OF STRUCTURAL KEY PLANS

Structural key plans are very detailed scantling plans that show all aspects of the vessel's structure. The vessel is divided into three main divisions with each division having its own key plan. The first area is the forward structure from the stem to the collision bulkhead; the second is the cargo hold structure between the collision bulkhead and forward machinery bulkhead; and the third is the after body structure, including the machinery space and after peak structures. All frames, bulkheads, decks, flats, stringers, stiffeners, shell plates and major penetrations, along with most major equipment foundations, are included on each respective key plan.

The primary purpose of the key plans is to provide a document depicting all details related to the vessel's major structural components for use by all departments, both Engineering and Production, in their own respective functions or tasks related to the shipbuilding effort. For example, the Hull Drafting Section uses the data shown to develop the yard plans or unit drawings. The Piping Section uses the plans to locate major interferences of their piping runs. Production Planning uses the plans to aid in the unit breakdown development. Since the key plan is a tool for other departments, the drawings must obviously be completed very early to allow the accelerated Engineering completion dates to be met. This obviously requires all support tasks necessary for the development of the key plans to likewise be completed earlier.

The scantling plans and midship section should be finished with regulatory body approval prior to the start of the key plans. Finite element studies must be finished in support of the scantling and midship drawings. The vessel's lines should be completely faired and loaded to the data base. Basic damage stability calculations depicting intended vessel compartmentation, as well as longitudinal strength studies, should be concluded pre, or at least during, key plan stage.

B) CREATION AND MAINTENANCE OF THE DATA BASE

This function is one of the duties that was the responsibility of other departments under the conventional system. The data base is a storehouse of information that will, through the use of designated computer programs, define all structures within the vessel inclusive of the vessel's shell contours. The data base is developed or created in a systematic manner starting with the definition of the vessel's final faired lines. Then surfaces such as decks and bulkheads are added, along with shell longitudinal, traces and shell seams. This data base is updated and maintained through the span of the contract to reflect any and all developments that occur as production proceeds.

The data contained within the data base is used to develop computer prepared drawings. Any frame bulkhead or deck contour can be retrieved and drawn depicting the associated stiffeners. Once the drawings have been developed and the data base data verified, the data is used to control the N/C burning machines in the Plate Shop, the generation of templates, bending of frames, etc.

C) **REVIEW OF UNIT DRAWINGS**

Once the key plans are issued, the Hull Section will use them to develop the yard structural plans or "yard plans" that are sub-divided into each particular hull construction/erection unit. These unit drawings are complete with the smallest detail shown and defined to allow the preparation of the unit parts list, "UPL'S," from which the Mold Loft prepares the unit construction manuals, "UCM's." The UCM'S are the documents from which the steel is nested, marked, punched and burned within the construction sequence. Therefore, in order to assure the accuracy of the data released to Production, the Design Section will review the unit drawings to verify that all details are in accordance with the intended design and latest developments.

D) **PRODUCTION/ENGINEERING LIAISON**

Since the Design Section is responsible for the development of the key plans, questions and problems that arise during development of yard plans and N/C burning, input is channeled through the Design Section for resolution. Although this is not a new function of the Design Section, the amount of day-to-day involvement has intensified due to the increased detail of the actual design work now undertaken. Also, since the data base maintenance requires daily involvement, the flow of input to and from the Design Section has increased drastically.

II. GENERAL

Unquestionably, the most single dramatic impact zone outfitting technology has had on the Design Section is the responsibility of developing the structural key plans. As the key plan is a new development to the shipbuilding scheme, a brief description of the drawing, as well as the method used to create this drawing, is in order.

Once the ship's lines are faired, the data defining the molded contour of these lines are loaded to the data base. This data base is unique for each class of vessel or, if warranted, can be unique to each vessel within the class. The vessel's major structure such as decks and bulkheads are then added as shown on the vessel's scantling plans and arrangement drawing by defining the intersection of these structures with the shell contours. Once these structures are loaded, smaller structures such as shell, deck and bulkhead stiffeners are added. The data defining these structures includes the trace along the particular surface, the actual scantlings of the stiffeners and the associated cut-outs through other structures. This process is continued until the entire ship has been defined. (See Graphs No. DS-1 through DS-4.)

As the data for a particular section of the vessel is completed, the actual key plan drawing is started. Data is retrieved from the data base and passed to a graphic computer terminal. Here the data is verified and details are added, such as labels, small brackets, etc. This is done until all structure is shown in sectional, plan and elevation views. AS the views are completed, a hard copy of the data stored in the graphic terminal's storage area is produced to become the key plan. The drawing is presented in a booklet format to allow the data to be shown on an adequate scale, while at the same time allowing the drawing to be a manageable size. Each sheet is set to be "D" size (22 inches x 34 inches) with plan and elevation views drawn at a 1/8" to the foot scale and section views drawn to a 1/4" to the foot scale. These scales and drawing sizes have proven satisfactory to allow the key plans to be reproduced full size if needed or at a reduced size that will conform to a 11" x 17" format.

Avondale uses a combination of the "SPADES" computer system with a "CADAM" graphic package to create the key plans. The two systems are currently interfaced on a one-way street, i.e. SPADES to CADAM. However, to allow direct access from the graphic package of CADAM back to the vessel's data base, an interface will be developed either within SPADES or by a stand-alone program that will permit any developments created on the graphic terminal to be stored back to the data base. This will allow the data base to be automatically updated as the key plans are being created, thereby eliminating the additional step of revising the data base by hand so as to reflect these developments.

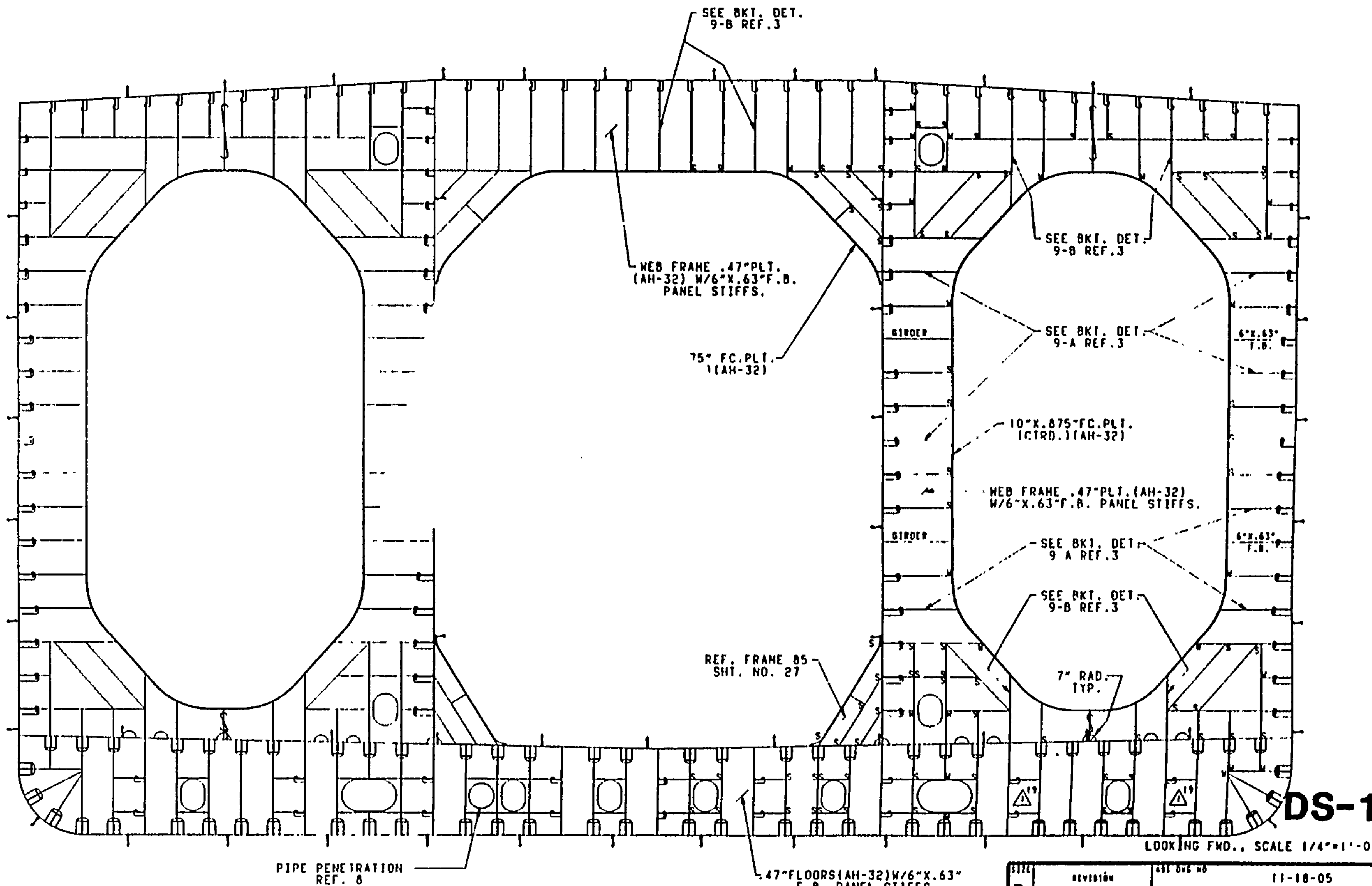
The key plans are issued to regulatory bodies, owners and all departments within Avondale as each is completed. Regulatory bodies, namely, the American Bureau of Shipping, will take review action on the key plans; however, the traditional scantling plans and midship sections are still required for approvals. The current practice at ASI is to start and issue the cargo block key plan first, the machinery space/after body drawing, and then the forward structure drawing. Zone outfitting as practiced by the Japanese is based on issuing the machinery space first, since most of the varied craft work required by the yard is in this area. This increase in craft work requires more lead time by the yard and, therefore, according to Japanese shipbuilders, Production should receive the drawings in this area as soon as possible. However, a basic difference between the U.S. and Japanese systems of shipbuilding exists that will not allow this to occur. The shipbuilding industry in the United States has not been able to standardize the components of the vessels not only between owners, but between vessel types. Since the components are not standard, additional time is required in Engineering to develop and procure these components. This additional time required would cause the "key plan completion" date to fall behind, thereby causing a snowball effect on the remainder of the Engineering effort.

Zone outfitting technology as applied to shipbuilding at ASI has caused several additional problems. Compounding the problems normally associated with starting a new system was the fact that ASI had ongoing work from existing contracts that was being done under the conventional system and schedules. Since the zone outfitting requires most work to be performed early within the contract period, some identical work on the existing contracts was being done or scheduled to be done in the same time frame of that required under the first IHI system contract. Obviously each department was affected by this fact to varying degrees, depending upon their own status of existing work. Since input from other sections is required for the key plan development, changes and revisions to the key plans were constantly required as a result of this bottle-neck situation.

Some problems associated with zone outfitting are inherent to the shipbuilding philosophy existing in the United States. Zone outfittng, as practiced by Japanese shipbuilders, does not take into account the numerous change orders that are associated with contracts in the U.S. The effect of these changes are such that production schedules are forced to slip if the changes are accepted. While some provision must be adopted to accommodate changes, additional provisions must be incorporated into the initial schedule or changes cannot be performed until after delivery if the schedules are to be met.

Another drawback to zone outfitting techniques for design engineering is that on some construction projects, such as single vessels or simple vessels such as barges, the increased time required for creating the key plans may not be justified. Therefore, the yard is faced with maintaining the dual system to some extent or being more restrictive to the type of vessels which can be taken under contract.

Zone outfitting employed at Avondale will lead to reduced time and cost required to design and build a vessel. The normal problems that are associated with any new system have largely been worked out in the first contract on which AS I employed zone outfitting tehcniques. There still remain some problems that must be considered and resolved, but both ASI management and personnel believe that the new system’s basic features of requiring schedules with earlier completion dates and the tools to allow these dates to be met will achieve the intended goal of reducing cost and manhours.



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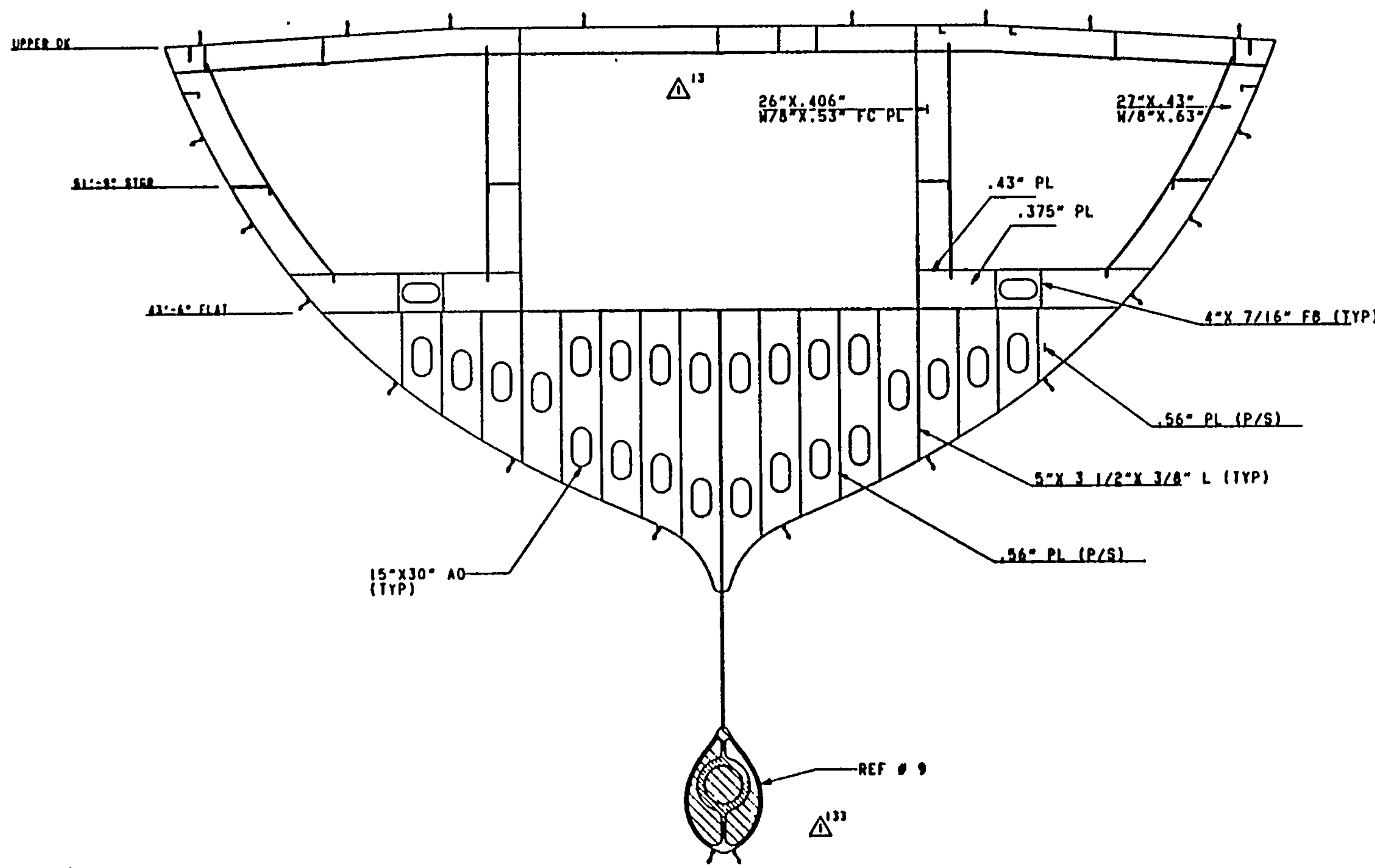

DETAIL 66-A

TRANSV WEB FR 10 LKG FWD

SCALE 1/4"=1'-0"

DS-2

SIZE	REVISION	ASI DWG NO
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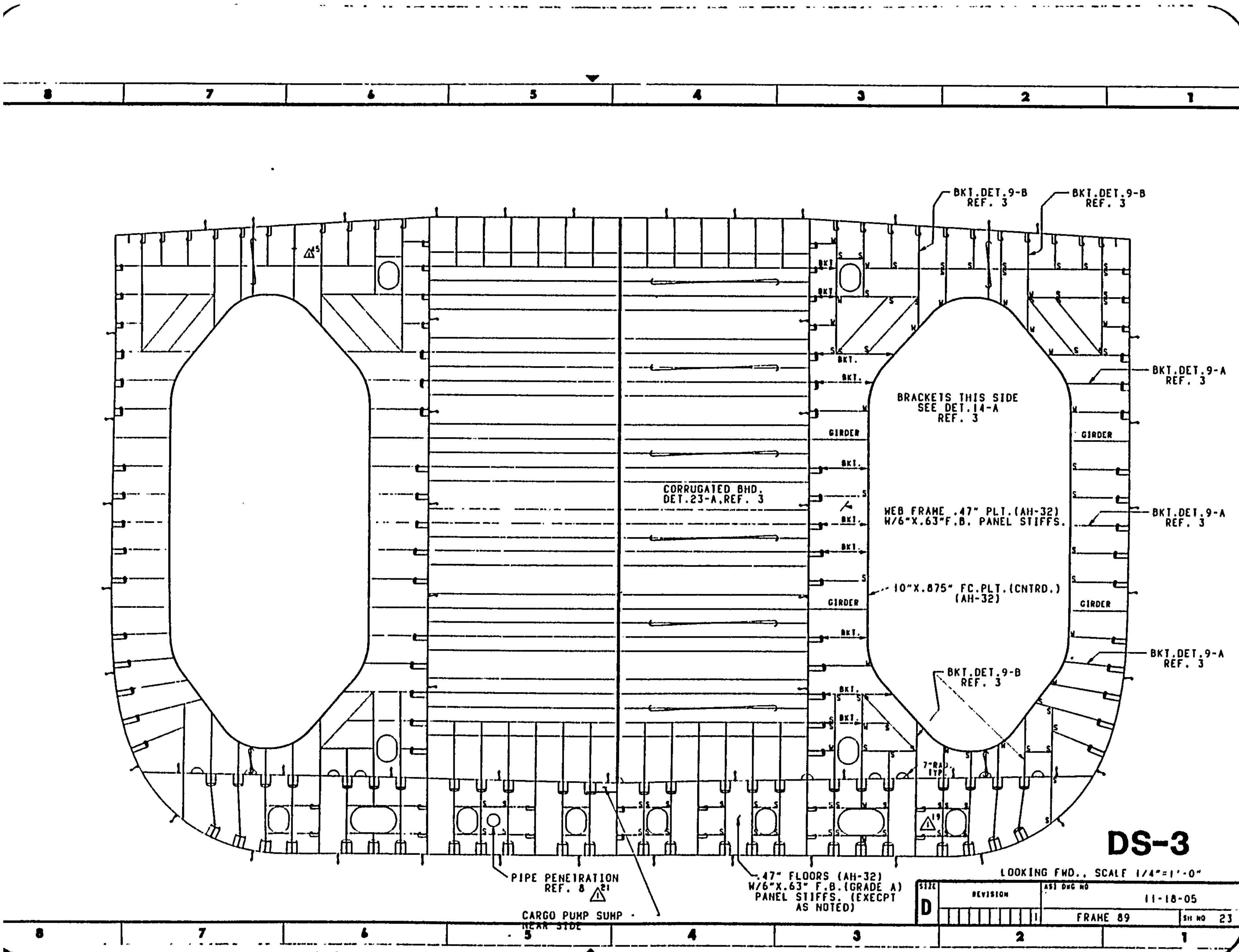
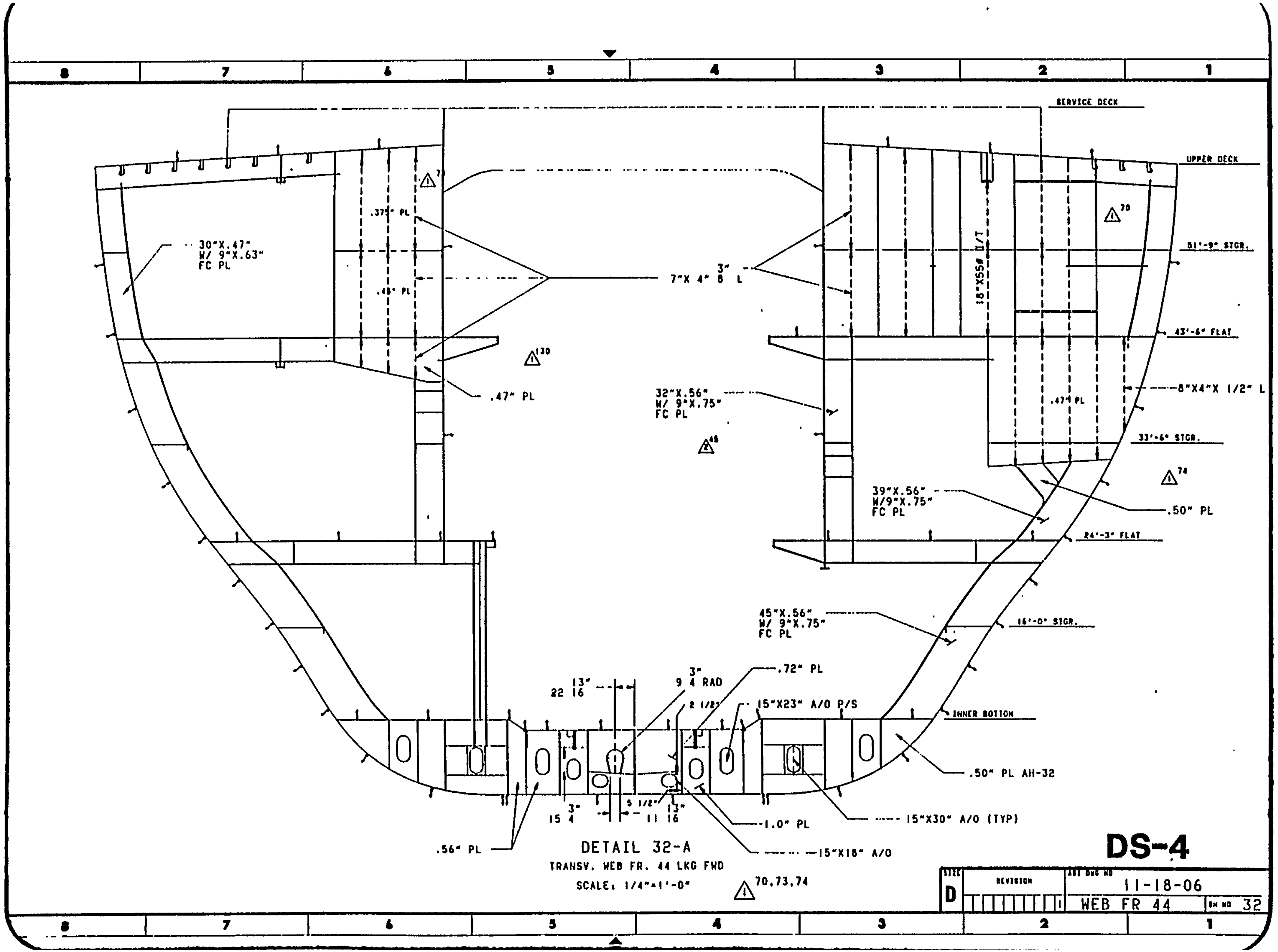
		SH NO 66


BKT.DET.9-B REF. 3
BKT.DET.9-B REF. 3
BKT.DET.9-A REF. 3
BRACKETS THIS SIDE SEE DET.14-A REF. 3
GIRDER
CORRUGATED BHD. DET.23-A,REF. 3
WEB FRAME .47" PLT.(AH-32) W/6"X.63"F.B. PANEL STIFFS.
BKT.DET.9-A REF. 3
10"X.875" FC.PLT.(CNTRD.) (AH-32)
GIRDER
BKT.DET.9-A REF. 3
BKT.DET.9-B REF. 3
BKT.
7"RAD. TYP.
PIPE PENETRATION REF. 8
CARGO PUMP SUMP - NEAR SIDE
.47" FLOORS (AH-32) W/6"X.63" F.B.(GRADE A) PANEL STIFFS. (EXECPT AS NOTED)
DS-3
LOOKING FWD., SCALE 1/4"=1'-0"
SIZE D
REVISION
ASI DWG NO
11-18-05
FRAME 89
SH NO 23


SERVICE DECK
UPPER DECK
51'-9" STGR.
43'-6" FLAT
33'-6" STGR.
24'-3" FLAT
16'-0" STGR.
INNER BOTTOM
30"X.47" W/ 9"X.63" FC PL
.375" PL
.43" PL
.47" PL
7"X 4" 3/8" L
18"X55# I/T
32"X.56" W/ 9"X.75" FC PL
8"X4"X 1/2" L
.47" PL
39"X.56" W/9"X.75" FC PL
.50" PL
45"X.56" W/ 9"X.75" FC PL
.72" PL
9 3/4" RAD
22 13/16"
2 1/2"
15"X23" A/O P/S
.50" PL AH-32
15 3/4"
5 1/2"
11 13/16"
-1.0" PL
15"X30" A/O (TYP)
15"X18" A/O
.56" PL
DETAIL 32-A
TRANSV. WEB FR. 44 LKG FWD
SCALE: 1/4"=1'-0"
70,73,74
DS-4
D
REVISION
11-18-06
WEB FR 44
SH NO 32

DESIGN ENGINEERING FOR ZONE OUTFITTING
AVONDALE SHIPYARDS, INC.

HULL SECTION (YARD PLANS)

DESIGN ENGINEERING FOR ZONE OUTFITTING
HULL SECTION (YARD PLANS)

I. INTRODUCTION

The group that we will be reviewing is known at Avondale Shipyards as the Hull Section. It is a group within the Engineering Establishment

II. TASK DESCRIPTION

A) GENERAL

Essentially, the Hull Section is an Engineering design development group.

The primary responsibilities of the Hull Section are to develop hull structural basic design concepts through the medium of drafting and to define, for requisition purposes, all associated hull materials for a given program.

The secondary responsibility of the Hull Section is to assist other Engineering disciplines and production, as necessary, in order to provide the required hull information.

The engineering drawings produced by the Hull Section are known as the “yard plans." The yard plan is composed of two (2) parts, the graphic portion and a structural material list known as the Unit Parts List. Both will be discussed in more detail later.

Sub Groups - In order to meet the above stated basic departmental responsibilities the Hull Section is organized into sub-groups, each assigned specific tasks, or work assignments, along with their attending responsibilities. By referring to the Hull Section Organizational Chart (Graph No. VA-5), we can identify four (4) separate sub-groups, namely, the Specialty Item Sub-Group, the Steel Take-Off Sub-Group, the Penetration Control Sub-Group, and finally the Vendor Review Sub-Group. Their assigned tasks and functions will be described below.

B) MATERIAL ORDERING

1) Structural Steel - Take-off Sub-Group

The Steel Take-Off Sub-Group is responsible for preparing bills of material and summary sheets for forwarding to the Engineering Department's Material Requisitioning Section. After initial take-off and summary sheets are forwarded to the Material Requisitioning Section, the group must continue to update and revise the initial sheets as the yard plans are revised.

2) Vendor Produced Items - Vendor Review Sub-Group

This group is responsible for the following objectives:

a) Review vendor drawings on equipment of Hull Section responsibility.

b) Review vendor drawings on equipment for which Hull Section provides foundations.

c) Maintain file for and track all vendor drawings associated with functions (a) and (b) above.

d) Write technical memos delineating necessary information so that Material Requisitioning Section can request material not ordered from ASI shop drawings.

e) Provide technical review service to Purchasing Department for vendor submitted quotes on Hull Section responsible material.

f) Monitor material schedules for Hull Section.

g) Provide assistance to Production Department on Hull Section responsible vendor equipment problems prior to vessel delivery.

h) Provide service to Guarantee Section for delivered vessels regarding vendor related equipment problems.

i) Correspond with vendors as required.

j) Maintain contact with Production Material Receiving Department to ensure timely arrival of purchased materials. Graph No. VA-13 depicts the V/R flow diagram.

3) **Miscellaneous Material**

Miscellaneous material appears on yard plans of some selected units, as well as on system drawings developed by the Speciality Item Group.

C) **SPECIALITY ITEM SUB-GROUP**

This group is responsible for the drafting of shop drawings and conceptual design development of the rudder support system, anchor handling system, mooring system, and all castings associated with the above mentioned mechanically oriented systems.

Material is ordered directly from these plans. The drawings are forwarded to the Material Requisitioning Section for processing prior to sending the material requisitions to the Purchasing Department.

Graphs VA-4A, VA-4B1, and VA-4B2 illustrate the material list from a selected yard plan and a system drawing.

D) **PENETRATION CONTROL SUB-GROUP**

This group is responsible for controlling the penetrations made in the ship's structure with the primary goal being the preservation of structural integrity.

1) The following functions are performed by the various Engineering Sections, in conjunction with the Penetration Control Sub-Group, to accomplish the penetration control objectives:

   a) Hole lists for all size holes are prepared by all Engineering Sections labeled as Rev. O and submitted to Hull Section for review/approval by certain dates established for a given program.

   b) Revised hole lists reflecting agreed upon locations with the Hull Section are completed by the scheduled dates. All changes made from the initial submittal to the Hull Section are noted as a revision.

   c) Holes to be N/C burned are forwarded to the Mold Loft, utilizing a sketch by the Hull Section by the scheduled dates.

d) Any required modifications to hole lists are forwarded to the Hull Section at once with special emphasis and final review of all penetration data prior to the "drop dead" dates.

e) After the Mold Loft has released a unit for fabrication, they advise the Hull Section which penetrations have, in fact, been N/C programmed.

f) The Hull Engineering Section marks a copy of the Particular Section's hole list to reflect three (3) categories of penetrations, NC = numerical control, FC = fabrication cut, EC = erection cut, and returns the hole list to the cognizant Section.

g) Each Engineering Section keeps the hole list current and advises the Hull Section immediately of any revisions. The hole lists are issued by each section to Production in accordance with the established schedule, predicated on all penetrations having received Hull Section approval.

h) Hull Engineering provides Production with a marked unit drawing showing the location of each hole as a supplement to the hole lists.

i) The Production Department has a specialized Hole Cutting Crew to cut the holes for all crafts in an effort to achieve proficiency in penetration cutting and locations. Hull Engineering works closely with this group to ensure the program's success.

Graph No. VA-7 shows a sample sheet from a typical hole list.

2) As mentioned in Item (c) above, the Hull Section provides the Mold Loft with sketches for holes that are candidates for numerical control burning. There are three (3) methods that are used to develop sketches.

a) Sketches that are drawn using the CADAM computerized drafting system - Graph No. VA-2A shows an example.

b) Sketches that are drawn using the SPADES /CADAM link - Graph No. VA-2C shows an example.

c) Sketches that are achieved by marking a print from the yard plan when a given unit has not been loaded on the SPADES data base - Graph No. VA-2B shows an example.

III. INFLUENCE OF ZONE OUTFITTING ON TASKS PERFORMED

A) DRAWING DEVELOPMENT METHODOLOGY - GENERAL

1) Structural Drawings

a) In the past, hull structural drawings were developed utilizing a system-by-system approach. The drawings were developed with the decks as a system, the shell as a system, the web frames as a system, and so on. We can think of these various structural components as systems of the hull envelope.

The system-by-system approach presented the entire shell, deck or longitudinal bulkheads to the Loft, from which the various units had to be extracted. The system-by-system drawigs did indicate the unit breaks or erection joints, but the individual unit's demarcation lines and extent were not so easily discernible graphically. Additionally, the system-by-system approach required the user to possess other system plans in order to know all of the components of a particular unit. Many reference plans were necessary.

Typically, the system-type plans were developed as rolled drawings of 10 to 20 feet in length. This was troublesome to the user in the field. The cumbersome size proved to be susceptible to wind action, becoming easily torn, water soaked, etc.

b) The greatest influence that zone outfitting technology had on the functions of the Hull Section was in the development of the hull structural plans.

Zone outfitting technology introduced four (4) major concepts for producing structural drawings:

(1) The structure was to be developed and presented unit by unit.

(2) The individual units would be developed from a Key Plan rather than from a rough scantling plan. The Key Plan conceptually is a more complete scantling plan delineating secondary structure to a more detailed level.

(3) The structural drawings would have their respective unit's components identified by a designation system that was keyed to the intended construction sequence or stages for that particular unit.

(4) Each unit drawing would be accompanied by a complete accounting list of material for that unit, known as a Unit Parts List.

Graph No. VA-1 is a flow diagram developed from IHI reports and discussion sessions that sets forth the method that the Hull group at IHI uses to develop their yard plans. ASI essentially has adopted this procedure with some revisions to accommodate individual capabilities and facilities. Graph No. VA-14 is a flow diagram of the yard plan.

2) **System Drawings**

ASI still maintains the obviously required system drawings, such as the rudder support system, mooring system; and anchor handling system. Zone outfitting technology has not had a profound effect on the development of these system drawings. Their development methodology has essentially remained unchanged.

B) DRAWING DEVELOPMENT METHODOLOGY - DETAIL

1) Structural Drawings - yard Plan

a) Standards

The adoption of zone outfitting technology has led to the creation of a large number of standardized structural details, such as the one depicted by Graph No. vA-6 .

The adoption of standardized structural details has led to uniformity in configuration and application. Repetitious detail requirements are simply referred to the standards. Details that may be repetitious for a given contract, but not necessarily an ASI Standard Detail, are drawn once, reproduced, and placed on the various unit drawings requiring them. (See Item No. 3-9 on Graph No. VA-1 .)

Some standardized notations, where certain letters of the alphabet singularly or in combinations are assigned certain meanings, are used in the yard plans. These standardized notations are directly tied to ASI'S Standard Structural Details. Graph No. vA-8 is a listing of some standardized notations.

b) **Symbolic Logic**

The next area where the adoption of zone outfitting technology has had an influence is in the use of symbolic logic. Prior to zone outfitting, ASI structural plans utilized symbolic logic to some degree. NOW, the use of symbolic logic has increased significantly. Symbolic logic is now used to denote mold line side, dimensioned side of member, stock allocations, etc. In the future, additional symbolism will be utilized in an effort to further standardize repetitious meaning or intent, and thus reduce wording or graphic presentations on the plans. The attending cost saving is an obvious initiating factor.

Graph No. VA-9 is a sample of symbolic logic presently used.

c) **Unit Parts List**

The next area where the adoption of zone outfitting has a significant influence lies in the decision to create a document known as the Unit Parts List, or UPL. Essentially, the UPL is a document that accounts for all the pieces in a unit. In addition to accounting for every piece, the pieces are presented to the user in the order of ascending stages of construction, grouped into the various partial sub-units, sub-units, and pieces required for both the assembly and erection stages of construction. The UPL is an accounting system that presents its information in the same order as the document produced by the Production Planning Department, the "Unit Breakdown Summary Sheet." Graph No. VA-10 depicts a typical unit breakdown summary sheet.

It is from the "Unit Breakdown Summary Sheet" that the UPL is constructed. There are additional items of information that are contained in the UPL. These additional items of information are notations to the Loft as to what pieces require "lofted" dimensions, what pieces require stock, what pieces require special attention in the lofting and manufacturing stages, etc. The UPL will be used at the various work stations.

It is envisioned that the UPL will be a baseline document that can be used by other groups or departments in Production for such functions as material accounting, sorting, routing, storage, etc.

Graphs VA- 3A and VA- 3B depict a sheet from the UPL for a partial sub-unit and a combined partial sub-unit for Unit 73 on the Exxon program.

d) **Seachests**

Until the adoption of zone outfitting, the seachests were classed as a system and detailed on one drawing, totally divorced from the structural drawings. Now, the various seachests are detailed with their respective units in the yard plans. This concept has the advantage of 1) placing all structural elements of the unit together, and 2) eliminating the need to look for a reference document.

e) **Penetrations**

Penetrations in structural components, due to piping, ventilation, mechanical and electrical routings are presented in the yard plans when those penetrations fall into either one of two categories: penetrations requiring structural reinforcement, and those that can be cut by numerical burning.

Until the advent of zone outfitting, only the penetrations that required structural reinforcement were shown. Zone outfitting technology has provided for earlier identification of system routings, with the attending benefit of being able to include those penetrations into the yard plans.

f) **Process Lanes Integration**

As mentioned earlier, under the discussion of the Unit Parts Lists, the concept of process lanes has been incorporated into the yard plan. The notations for the various structural components, designating them as sub-units, partial sub-units, combined partial sub-units, or just individual pieces to be left loose until assembly or erection, are a function of the area or location of their manufacture.

This designated manufacturing location is one of the basic concepts of the process lane principle. The yard plan notations are gotten from the Unit Breakdown Summary Sheet prepared by the Production Planning Department. By knowing the meaning of the process lane coding notations, one can determine the location of manufacture of a particular structural component. Graphs No. vA-3A and No. VA-3B show some of these notations.

g) **Foundation Supporting Structure**

Pieces of structure required to support local foundations are included in the yard plans for a particular unit requiring them. These pieces of structure range in size from simple headers to full depth, built-up girders. The piece marking of these structural components is treated the same as for ordinary structural components. Individual piece marking is numerical, sequential, per unit. Letters are not used.

2) **System Drawings**

a) **Above Deck Foundations**

Foundations that are above deck are detailed on the applicable system drawing, such as the mooring system or anchor handling system. These foundations can be manufactured at a separate selected site and be kept from the various unit manufacturing work centers. These foundations can be placed on the unit during the assembly stage. When this is the case, these structural members are pallet-coded to be brought to the assembly area for installation. They are piece-marked sequentially, numerically, per system drawing.

b) **Foundation Supporting Structure**

As mentioned previously (under Article (B) (1)(g)), the underdeck supporting structure for system foundations are detailed on the yard plans. They are only referenced on the system drawing.

C) **DRAWING FORMAT**

1) **Structural Drawings - Units - Yard Plans**

a) The format used previous to the introduction of zone outfitting technology was the conventional rolled type drawing. These drawings ranged in length from ten (10) to twenty (20) feet, depending on subject matter. In some cases, more than one rolled drawing was required to present all the necessary details to manufacture a structural system, such as web frames.

b) With the introduction of zone outfitting, the basic format of the structural plans was changed to the booklet type. only one unit is detailed in any given booklet. The booklet's presentation is so arranged that the various structural components of the unit are presented in their main order of component assembly. The first component of a unit to be assembled is placed first in the booklet. Graphs VA-15 through VA-19 depict a typical yard plan booklet.

2) System Drawings

The format for the various system drawings developed by the Hull Section is as follows:

a) Rudder Support:	Arrangement - Rolled Details - Booklet
b) Rudder:	(classed as unit) Booklet
c) Mooring System:	Arrangement - Rolled Details - Booklet
d) Anchor Handling:	Rolled

3) Miscellaneous Drawings

The format for the various miscellaneous drawings developed by the Hull Section is as follows:

a) Mold Line Plan:	Booklet
b) Docking Plan:	Rolled
c) NDT:	Booklet
d) Rudder Horn:	Rolled
e) Stern Frame:	Rolled
f) Hawse & Chain Pipe:	Rolled

It should be noted here that all of the above listed miscellaneous drawings were developed by the Hull Section previous to the introduction of zone outfitting, except one - the Mold Line Plan.

The Mold Line Plan is a direct result of an IHI concept presented to ASI, whereby the mold lines of all of the primary structural components of the hull and superstructure are set forth in one document. The establishment of the mold lines is one of the first activities performed by the Hull Section after “Go” date. This information is forwarded to all Engineering Sections, particularly the Composite Groups and the Mold Loft. This vital information preceeds the issuance of the yard plans. Previously, this information was disseminated in sketch form rather informally. Now, it is a formally organized document. Graph No. VA-12 is a sample sheet from a Mold Line Plan.

Finally, with regard to drawing format, it must be said that some subject matter, such as the Docking Plan, does not lend itself easily to booklet type presentation. Where this situation exists, the subject matter should be presented in a rolled drawing format.

D) MATERIAL ORDERING

1) Structural Steel

a) Steel Bills of Material

The one major effect that zone outfitting technology had on the ordering of structural steel was to change the material grouping on the steel bills from a system-by-system concept to a unit-by-unit grouping. Each unit has its own applicable steel bills. Graph No. VA-11 is a sample sheet of a steel take-off sheet on the Exxon program.

3-6

The checker in charge of the ship prepares the drawing list. This drawing list is prepared in consideration of the main assembly schedule and similar construction of units.

3-7

The blueprints are cut with scissors, separately, following the preparation of the drawing list.

3-8

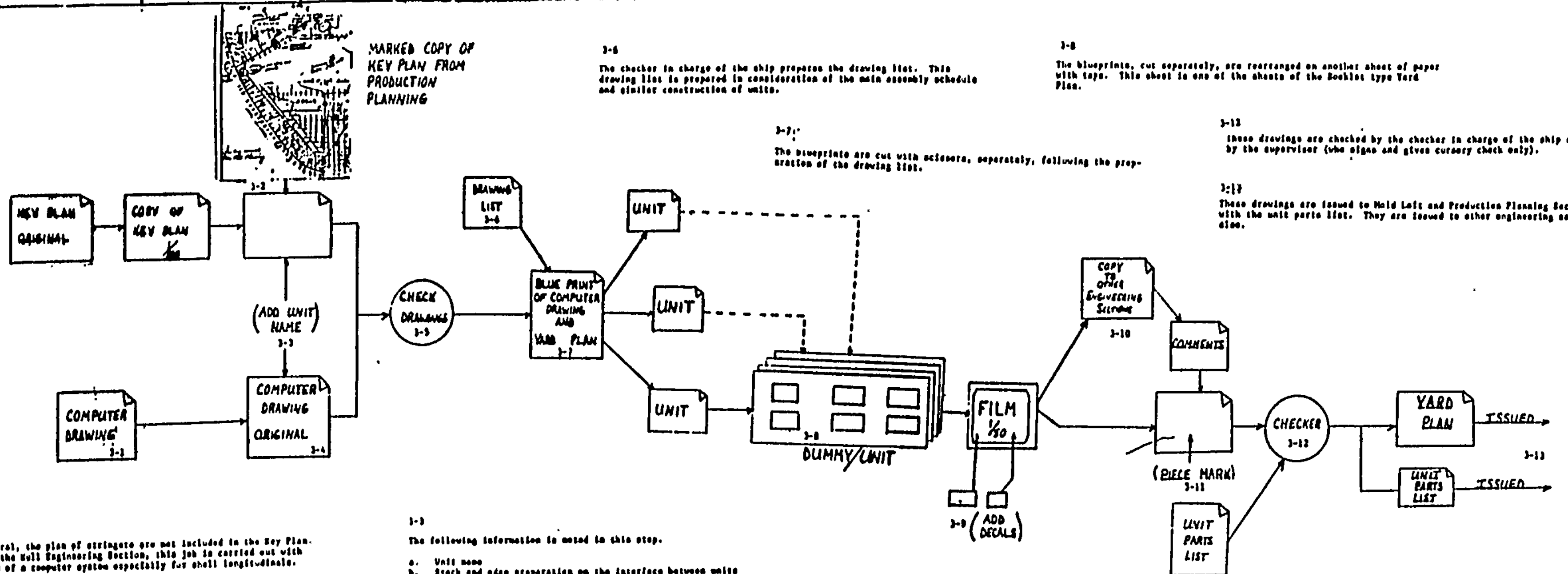
The blueprints, cut separately, are rearranged on another sheet of paper with tape. This sheet is one of the sheets of the Booklet type Yard Plan.

3-12

These drawings are checked by the checker in charge of the ship and by the supervisor (who signs and gives cursory check only).

3-13

These drawings are issued to Mold Loft and Production Planning Section with the unit parts list. They are issued to other engineering sections also.



3-1

In general, the plan of stringers are not included in the Key Plan. So, in the Hull Engineering Section, this job is carried out with the aid of a computer system especially for shell longitudinals.

In this step, the drawing includes many units in length, and the erection joints. The location of web frames or transverse bulkheads are also shown:

3-2

Information is sent to Hull Engineering from Production Planning after the assembly procedure has been planned by using the Key Plan.

In this drawing, assembly procedure, edge preparation for welding and stock and burning methods are noted.

3-3

The following information is noted in this step.

a. Unit name
b. Stock and edge preparation on the interface between units
c. Erection joint of longitudinals
d. Indication of the internal construction members of the unit

3-4

In this step, the following information is noted to complete the longitudinal section.

a. Stock and edge preparation on the interface between units
b. Drain hole, air hole, scallop and water stops
c. Shape of stiffeners (flat bar, bracket, inverted angles) on the longitudinals

3-5

These drawings are checked by the person in charge of the ship.

3-9

The stick-on decals (film sheet with sticker on back is copied as many times as required then cut up and applied to the drawing) are prepared for the details that apply to the ship. These details are not standardized but used repetitiously for that one vessel.

3-10

At this step, the yard plan drawing is almost completed and is issued to other engineering sections to discuss the penetrations and reinforcements.

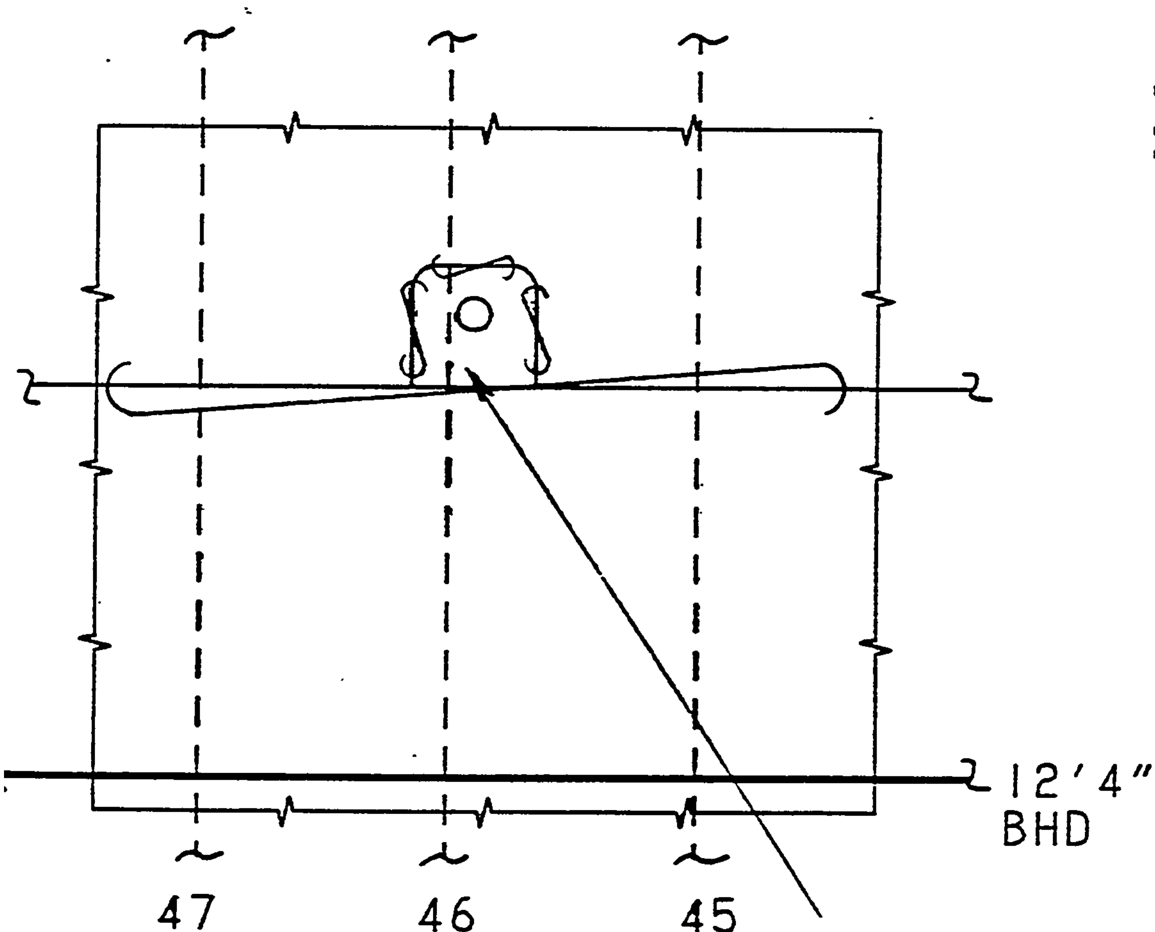
3-11

After discussing with other engineering sections, the location of penetrations and reinforcements are noted and some design changes are made, if necessary. The details for hull construction are then added and piece marks are noted for each piece. The unit parts list is then prepared for each unit.

ENGINEERING

TRATION NOTICE | REV. △

VA-2A



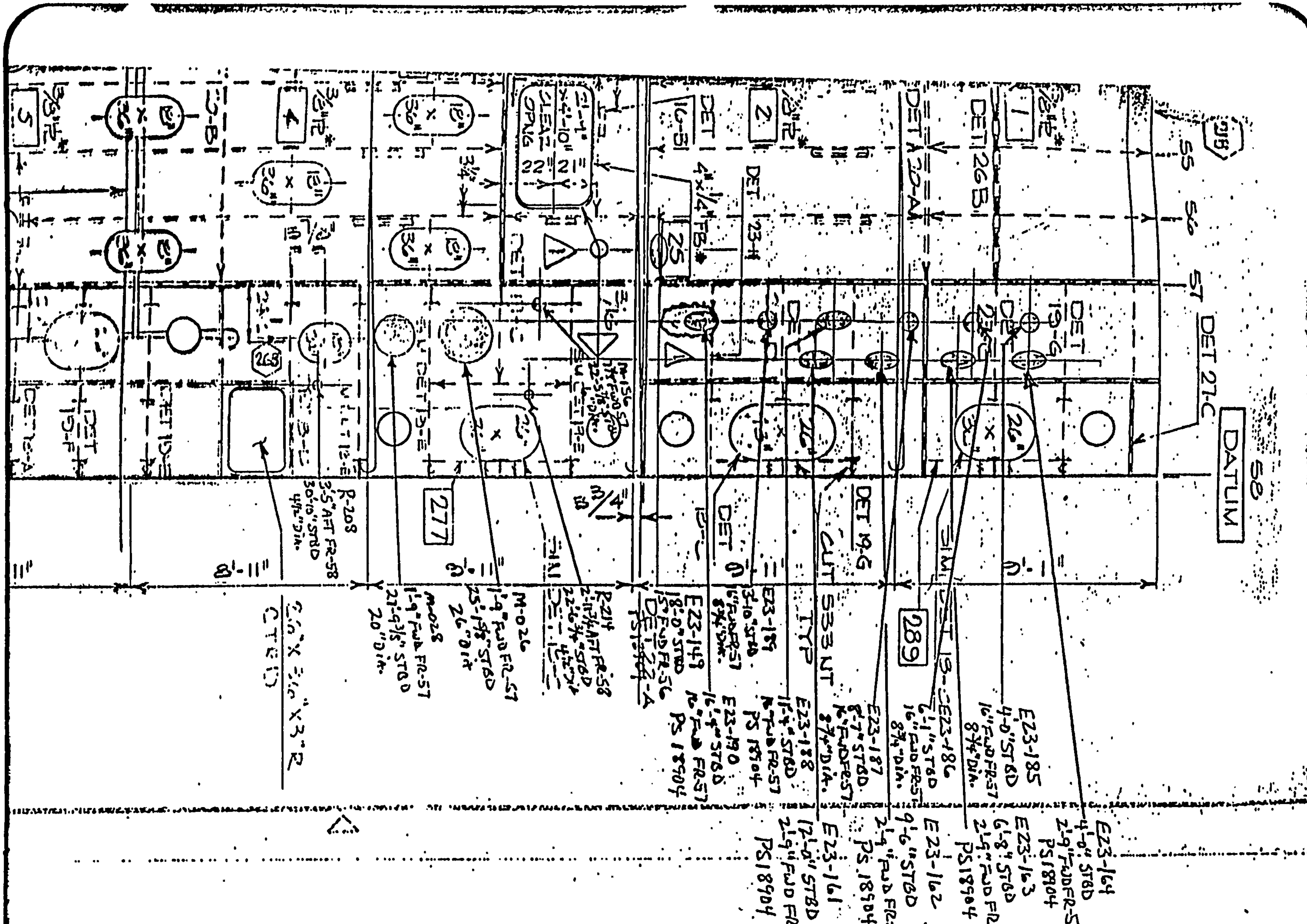
ABS M.S.
15"X 15"X 3"RAD
11/32"PL INSERT
TO REPAIR HOLE
CUT IN ERROR

DETAIL 14-C

UPPER DECK STBD

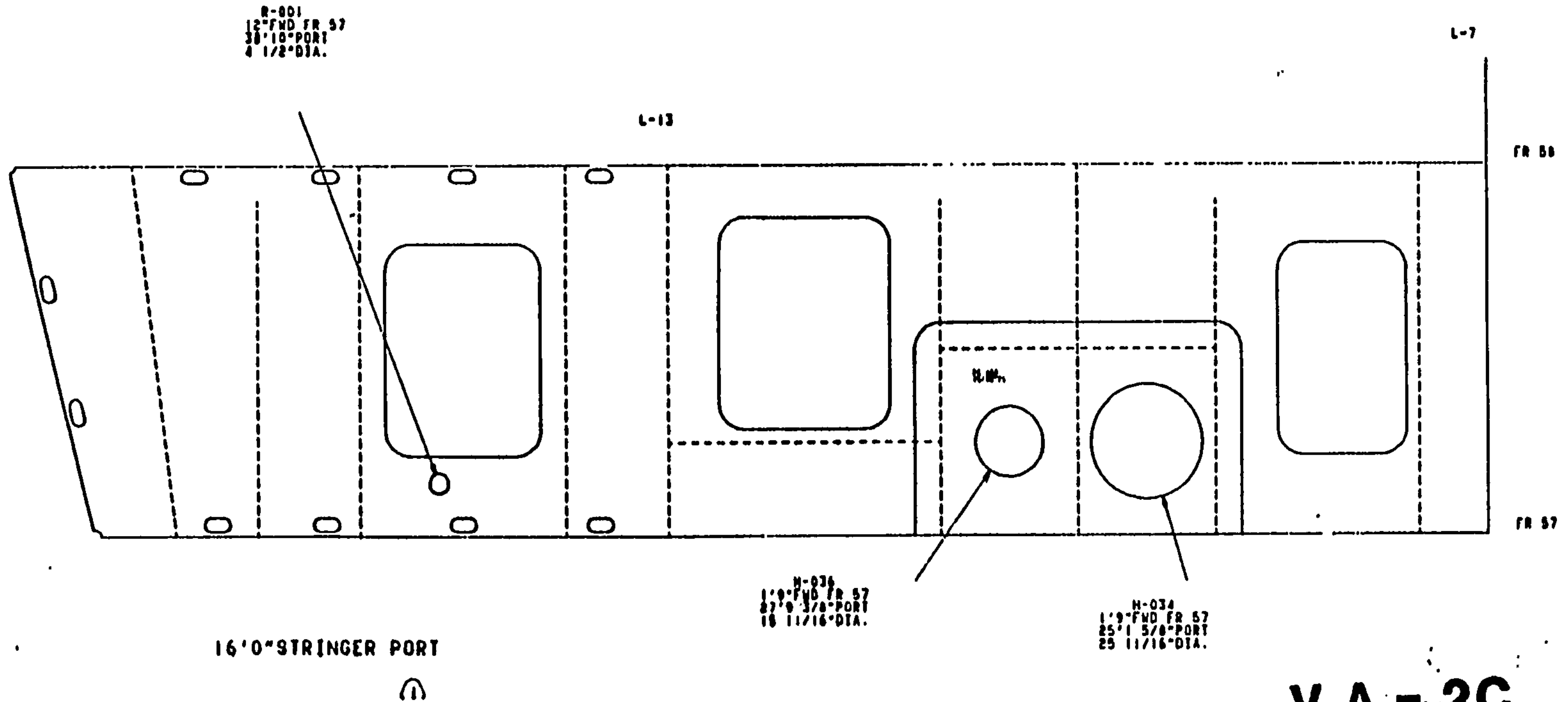
UNIT 144

9-215	HULL NO	REF DWG NO
S.	CHECKED	11-06-10
	DATE 3-11-82	SHEET


DATUM
DET 27-C
DET 26 B
277
289
CUT 533 NT
TYP
EZ3-149
EZ3-164
EZ3-185

V A - 2B

INIT 8,PC.NO.47
DWG 00-008-005
JAN.13,1982



VA-2C

PG MARK	STG	PL	$	SIZE	GR	QTY P	QTY C	QTY S	WT	END CUT INFO	DET	REMARKS	MOLD LOFT INF
002-003)											10-A		
44		X		½" PL x 72" x ___	AH32			1			↓	(S) ½"	
45		X		↓ x 119" x ___	↓			1			↓		
46			X	6" x ½" F.B. x ___	A			2		E7 x E9	10A 12E		
47			X	x ___				1		E4 x E9	12B		
48			X	x ___				1		E5 x E9	12G		
49			X	x ___				1		E7 x E9	12F		
50			X	x ___				1		E7 x E4	12H		
51			X	x ___				2		E5 x E7	12J 12E		
52			X	x ___				2		E7 - E5	↓		
55			X	↓ x ___	↓			1		E7 x E4	↓ 12E		
58		X		1" PL x 10" x ___	AH32			1			10-A	Roll ½"	
(002-004)											10-A, 12D		
56		X		17/32" PL x 42" x ___	AH32			1			↓		
57			X	6" x 5/8" F.B. x ___	↓			1		E7 x E7	↓		
70			X	6" X ½"	↓			1		E5 - E4	12D/12F 12E		

VA - 3A

UNIT PARTS LIST	SIZE	REVISION	ASI DWG NO
	A	1	C1-15 00-073-005
			UNIT No 73 · SH NO

<002-003>
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<002-020>
<002-023>

VA-3B

UNIT PARTS LIST

SIZE	REVISION	ASI DWG NO
A	1	C1-15 00-073-0
		UNIT No 73

SH N

PARTS LIST (QUANTITIES FOR ONE VESSEL)

ITEM NO	QTY	DESCRIPTION	MATERIAL	REMARKS	SH
1	20	3/4"-10 UNC-2A x 2 1/2" LG HEX HD BOLT	MONEL		20
2	20	3/4"-10 UNC-2B HEX NUT	MONEL		20
3	2	4" 150# STL SLIP-ON FLG	ASTM A-105 GR 1/2	ANSI B16.5	19
4	1	8" 150# STL SLIP-ON FLG	ASTM A-105 GR 1/1	ANSI B16.5	19
5	1	10" 150# STL SLIP-ON FLG RAISED FACE	ASTM A-105 GR 1/1	ANSI B16.5	19

SIZE	REVISION	AN DWG NO
C		C1-15-00-092-000
		PART LIST — SH NO 22

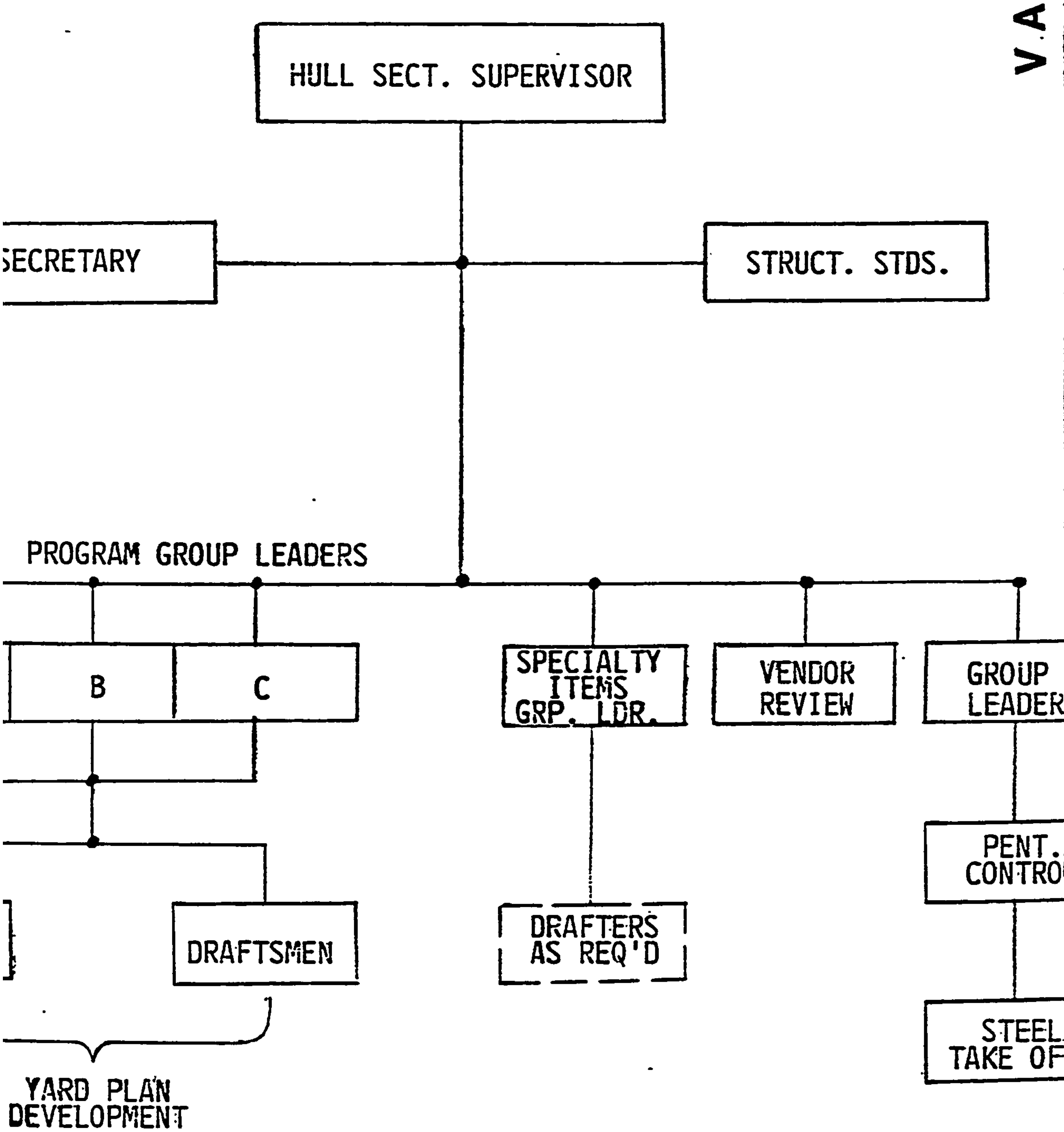
VA-4A

				FOR USE WITH ITEM 1	10
3	140	REG HCL SPRING LOCKWASHER	STL. ELECTRO GALV'D COMM'L	FOR USE WITH ITEM 1	10
4	40	¾"-10 UNC-2A HVY HEX HD BOLT	STL. ELECTRO GALV'D ASTM-A307, GR. A	LGTH-4"	10
5	40	¾"-10 UNC-2B HVY HEX NUT	DO		10
6	40	REG HCL SPRING LOCKWASHER	STL ELECTRO GALV'D COMM'L		10
7	2	TOWING BRACKET PIN	STL AISI 1045 84000 PSI TENSILE 10000 PSI YIELD	LGTH-15⅝" MACH. FROM 6½" RD. BAR	23
8	2LF	3/16" DIA. (7x7) WIRE ROPE	STN. STL. COMM'L.		23
9	4	WIRE ROPE SOLDERLESS CONNECTOR	BRASS-TIN PT'D COMM'L	FOR PC. NO. 8	23
10	28	ROLLER GUIDE SHAFT	HOT ROLLED STEEL AISI-1018	LGTH-5¼" MACH FROM 4" DIA. RD. BAR	25
11	28	GREASE FITTING	MONEL COMM'L	ALEMITE NO 1962-B OR EQ.	25
12	28	FLAT WASHER	BRONZE SAE 60	4¾" O.D. x 3 1/16" I.D. x ¼" THK. 1/16" x 1/16" CHAMFER BOTH SIDES ON I.D.	25
13	28	BUSHING	DO	3¾" OD x 3" I.D. x 3¼" LG.	25
14	56	⅝"-11 UNC-2A HVY HEX HD. BOLT	STL ELECTRO GALV'D ASTM A307 GR. A	LGTH-2"	25
15	56	⅝"-11 UNC-2B HVY HEX NUT	DO		25
16	56	REG HCL SPRING LOCKWASHER	STL ELECTRO GALV'D COMM'L		25
17	55 gal.	CHOCK	RESIN	PHILADELPHIA RESIN "CHOCKFAST GREY"	10

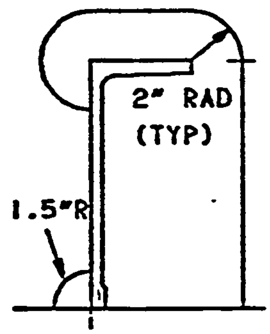
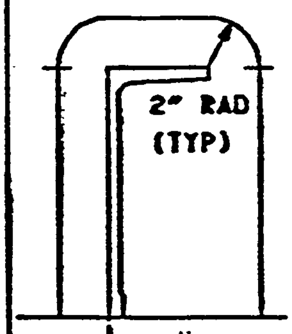
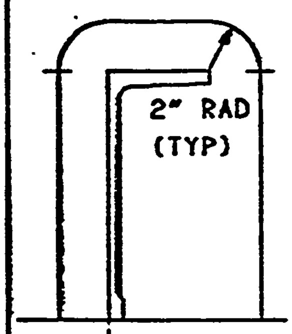
VA-4B1

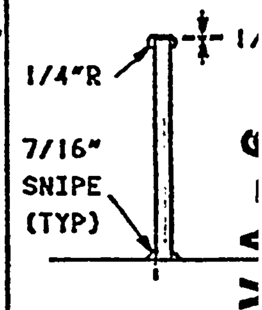
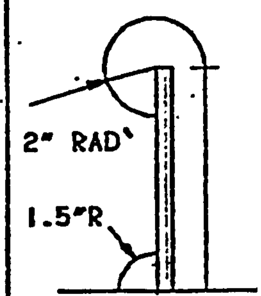
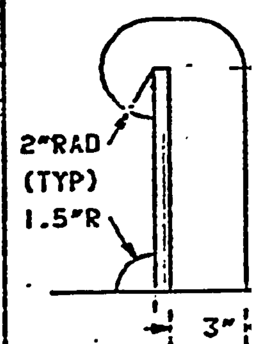
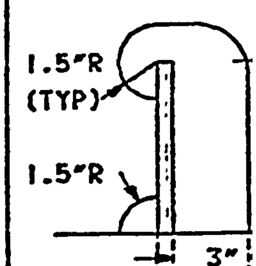
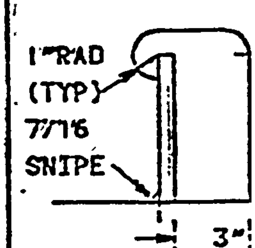
QUANTITY OF MATERIAL PER PALLET																
PALLET CODE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
16-M51-1Y	28	28	28	20	20	20	1	1 LF	2							
16-M52-1Y	28	28	28	20	20	20										
16-D51-1Y	28	28	28	20	20	20										
16-D91-1Y	42	42	42	30	30	30	1	1LF	2							
16-D92-1Y	14	14	14	10	10	10										
16-014-1T										2	2	2	2	4	4	4
16-026-1T										4	4	4	4	8	8	8
16-015-1T										6	6	6	6	12	12	12
16-118-1T										4	4	4	4	8	8	8
16-128-1T										4	4	4	4	8	8	8
16-117-1T										4	4	4	4	8	8	8
16-129-1T										4	4	4	4	8	8	8

HULL SECTION
ORGANIZATIONAL CHART



VA-5

DBCT#	MEMBER	SIZES	TYP. CONFIG.
02NT	DEFL CN	18" & UNDER ALL	
52NT	DEFL CN	18" & UNDER ALL	
02WT	DEFL CN	18" & UNDER ALL	

DBCT#	MEMBER	SIZES	TYP. CONF
101WT	SLABS AND FB	18" X 2" & UNDER ALL	
101NT	SLABS AND FB NOT REQ CLIPS	18"X 1" & UNDER ALL	
111NT	SLABS AND FB	18" - 8" ANY THCK	
121NT	FLAT BAR	7"	
131NT	FLAT BAR	6" & UNDER ALL	

RATIONALE

CONFIGURATION CUT-OUTS TO BE AS SHOWN.
DEPTH AND FLANGE DIMENSIONS, THICK.
AS LOADED IN SPADES DATA BASE.

(FILE DB3.F1 RA3B.SP)

0	M-12	18" DIA HOLE	ROUND	00063005	43'-6" FLAT	4'-3" AFT FR 30	22'-6" OFF CL PORT	43'-6" ABL
0	M-13	18¼" DIA HOLE FOR 18" DIA COAMING	ROUND	00078005	MN DK	4'-3" AFT FR 30	22'-6" OFF CL PORT	MN DK

1 LONG ℄ AXIS F & A
2 LONG ℄ AXIS P & S
3 LONG ℄ AXIS VERTICAL
4 STRUCTURALLY REINFORCED

SH. 6

JOB Nº	DWG Nº	REV
C1-15	55:01:079	0

VA-7

9. Standard Abbreviations

Several abbreviations have been established for words as they relate to ASI's Standard Structural Details booklet. It is important to remember that these abbreviations are used in codings and element descriptions in the Structural Standards book and must not be substituted with any other abbreviations in the detail sheets. The structural standards abbreviations are listed below.

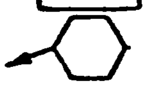
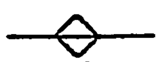
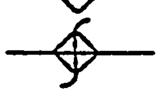
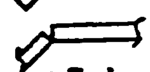
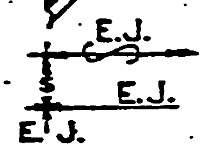
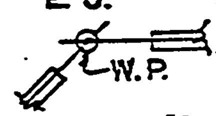
Letter		
Capital	Lower Case	Meaning
N		Non
W		Water
W		Width
L		Large Cut
L		Length
T		Tight
R		Reinforced Clip
C		Combination
B		Bracket
T		Tees
A		Angle
F		Flat Bar
	w	Weld Fillet Size
CN		Channel
H		Wide Flange Beam
IT		Deflanged Wide Flange Membe
HT		Height
TH		Thickness
HO		Hole
CH		Chock
CL		Clip
PL		Plate
CT		Cut Out
CO		Collar

Abbreviations for words other than those that relate to the Structural Standards book may be obtained from ANSI standards.

VA-9

10. Symbolic Logic

Geometric designs, letters and numerals, separately, or in combination, may be established as symbols possessing pre-determined meaning. Once a pre-determined meaning is assigned to a symbol, then the "logic" of the symbol is established, thus the term "Symbolic Logic". The below listed standard symbolic logic is to be used in Hull Engineering Drawing booklets.

Symbol	Meaning	Example
	Continuous Thru	
	Member Extent	
	Alteration	 Item 2 of Alt. 3
	Piece of Structure	
	Butt Weld Joint Designation	
	Butt Edge-One Plate to Another	
	Bend or Knuckle Line	
	Knuckled Seam	
E.J.	Erection Joint	
W.P.	Work Point	
G.N.	General Note	G.N. #3
L21	Member Location	Long. #21
 Short Tail Arrow	Place member at tail of arrow to member at head of arrow in "fabrication" stage.	
 Long Tail Arrow	Same as above, except in "Assembly" stage.	

VA - 10

UNIT #105 (CATEGORY #1) WGT.(TONS) DATE: 03/09/82 REV.#1

TRANSV. O.T. CORRUGATED BHD. FR. 89.
HULL "B" & "H" ONLY
(DWG. 0G-104-000)

A. PARTIAL SUB UNIT #105-001-001
WORK CENTER - PLATEN #24
FABRICATE (6) BKTS. DET. THEN SEND THEM TO PLATEN #20 SUB ASSEMBLY STAGE.

B. SUB UNIT #105-001
WORK CENTER - PLATEN #20 - SUB ASSEMBLY STAGE
SUB ASSEMBLE THE CORRUGATED BHD. PLATE FR. 89 WITH FWD. SIDE UP FABRICATE AND SUB ASSEMBLE THE CL. BHD. DET. SUB ASSEMBLE (4) FABRICATED BKTS.(P.S.U. #105-001-001), STRONGBACK BHD. AND TURN IT OVER. SUB ASSEMBLE TOP AND BOTTOM BKTS., (2) FABRICATE BKTS. (P.S.U. #105-001-001) AND F.B. HEADERS. WHEN COMPLETE MOVE TO PRE-OUTFIT STAGE ON PLATEN #20 IF REQ'D.

D. UNIT #105
WORK CENTER - PLATEN #20 - PRE-OUTFIT STAGE
PRE-OUTFIT IF REQ'D THEN MOVE IT TO PLATEN #20 FINAL ASSEMBLY STAGE

E. UNIT #105
WORK CENTER - PLATEN #20 - FINAL ASSEMBLY STAGE
CALL OUT FOR A.S.I. OWNER STRUCTURAL INSPECTION, COMPLETE PICK UP WORK, THEN SEND TO BLAST AND PAINT.

PLATE & STRUCTURAL TAKE OFF

PLATE & STRUCTURAL SUMMARY

VESSEL EXXON TANKERS

QUANTITY FOR 1 VESSEL

DESCRIPTION 5/8" PL .625R

MATERIAL TYPE AH-32

SPEC. A.B.S.

JOB NO. C1-15

REQ. NO. 553-F

SHEET NO. 1 OF

DATE 12-17-81

STO. NO.	QUAN.	CUT SIZE REQUIRED	SUB. UNIT PC. NO.	DWG. NO.	REV	DET. NO.	USE	SUMM.	SUMM.	QUAN.	SIZE ORDERED	WT.	REMARKS / CODE	REV.
1	1	5/8" PL 108" x 29'-5"	2	00-061-5005		5-A	UPPER DECK FR. 58-49 P	4791	4791	2	5/8" PL 110 x 29'-7"	13844	02-02-03-000001	1
2	1	94" x 29'-5"	1				58-49 P	4792	4792	1	96 x 29'-7"	6041		
3	1	83 x 39'-9"	26			6-A	SHELL PLATE 58-44 P	4793	4793	2	84 x 39'-11"	14264	UNDER RESERVATION	2
4	9	9 x 39'-7"	9			5-A	UPPER DECK 58-44 P	4794	4794	14	9 x 39'-9"	10654	UM PLATE	
5	2	9 x 27'-9"	11,13				58-49 P	4795	4795	4	9 x 27'-11"	2136		
6	1	9 x 35'-4"	12				48-57½ P	4796	4796	1	9 x 35'-6"	680		
7	1	9 x 21'-10"	10				48-53 P	4797	4797	1	9 x 22'-0"	421		
8	5	9 x 7'-9"	8				57-58 P	4798	4798	1	96 x 34'-0"	6943		
9	12	9 x 2'-8"	16 17 19				45-56 P	4798	—					
10	9	9 x 2'-8"	22-25				45-56 P	4798	—					
11	1	9 x 4'-3"	21				57½-58 P	4798	—					
12	1	9 x 9'-4"	14				48-44 P	4798	—					
13	1	9 x 1'-3"	28			22-D	LONG. BHD 18'-6" OFF ℄ 45 P	4798	—					
14	1	9 x 2'-0"	232			5-A	UPPER DECK 57-58 P	4798	—					
15	1	108 x 29'-5"	5	00-062-5005			58-49 S	4791	—					
16	1	119 x 29'-5"	6				58-49 S	4799	4799	1	120 x 29'-7"	7551		
17	1	83 x 39'-9"	31			6-A	SHELL PLATE 58-44 S	4793	—					
18	5	9 x 39'-7"	7			5-A	UPPER DECK 58-44 S	4794	—				UM PLATE	
19	2	9 x 30'-3"	8				48-58 S	4800	4800	2	9 x 30'-5"	1164		
20	2	9 x 27'-9"	9				49-58 S	4795	—					
21	1	9 x 26'-0"	10				48-57½ S	4801	4801	1	9 x 38'-10"	743		
22	1	9 x 12'-6"	11				48-53 S	4801	—					
23	6	9 x 7'-9"	14				57-58 S	4798	—					
24	14	9 x 2'-8"	15, 17 17, 19				45-52 57½-58 S	4798	—					
25	15	9 x 2'-8"	18 20-22				45-56 S	4798	—					

1 ADDED LN. 1-25 ITEM 4791-4801] 3/12/82.

2 PLACED ITEM 4793 UNDER RESERVATION] 3/26/82

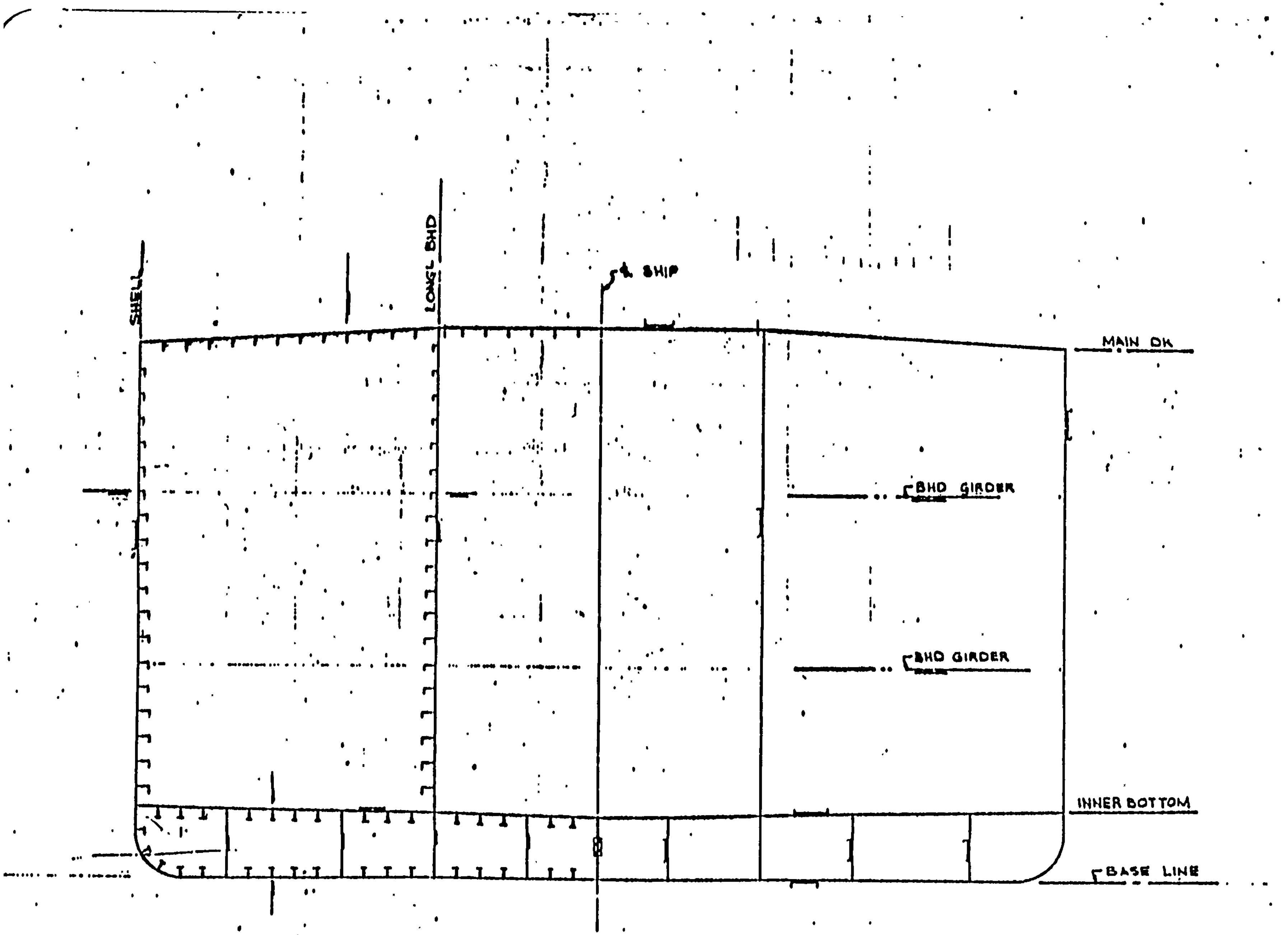
64441

UNIT 61 & 62

MATERIAL AH-32

DESCRIPTION .625 PL

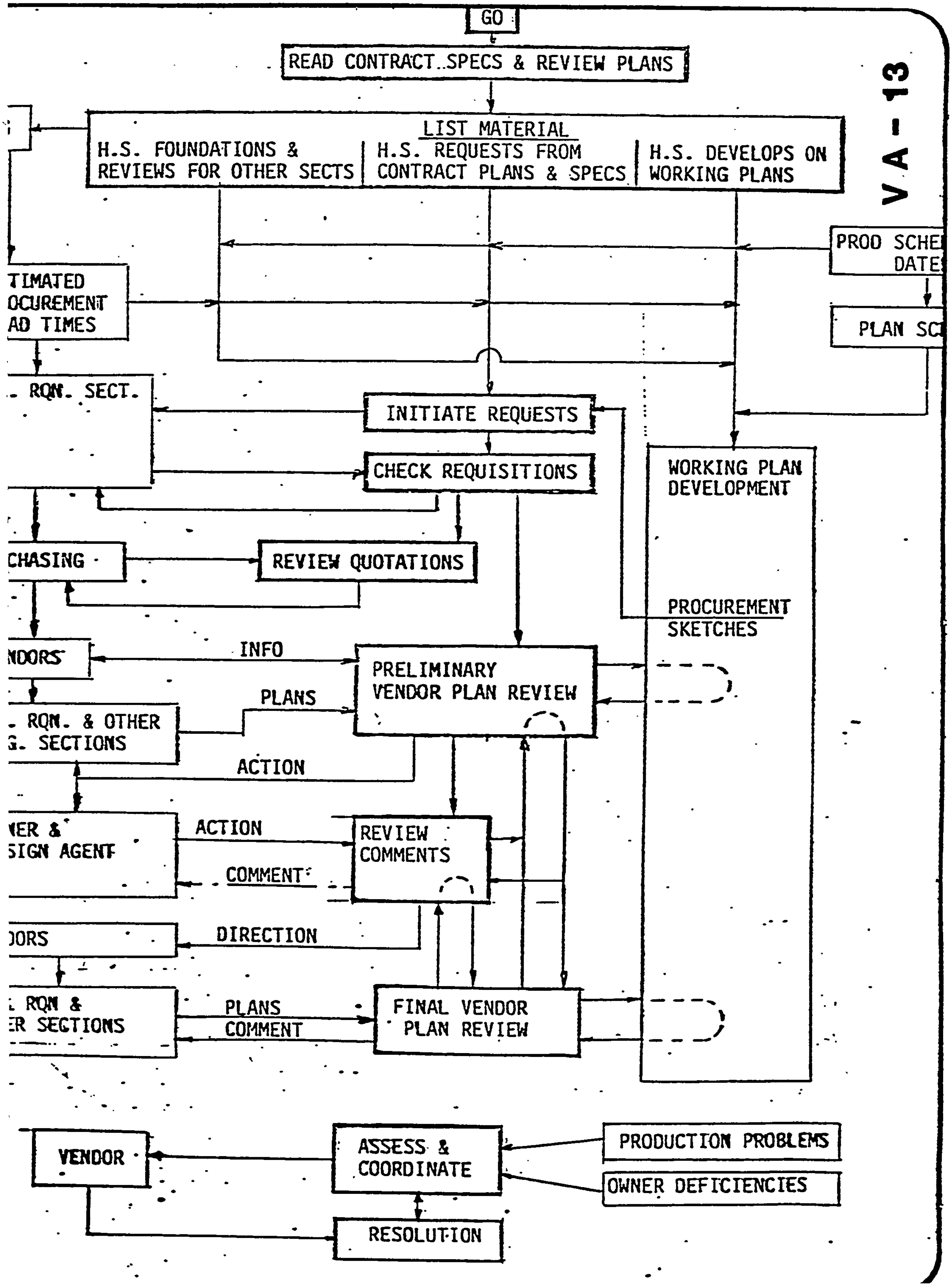
VA - 11



VA - 12

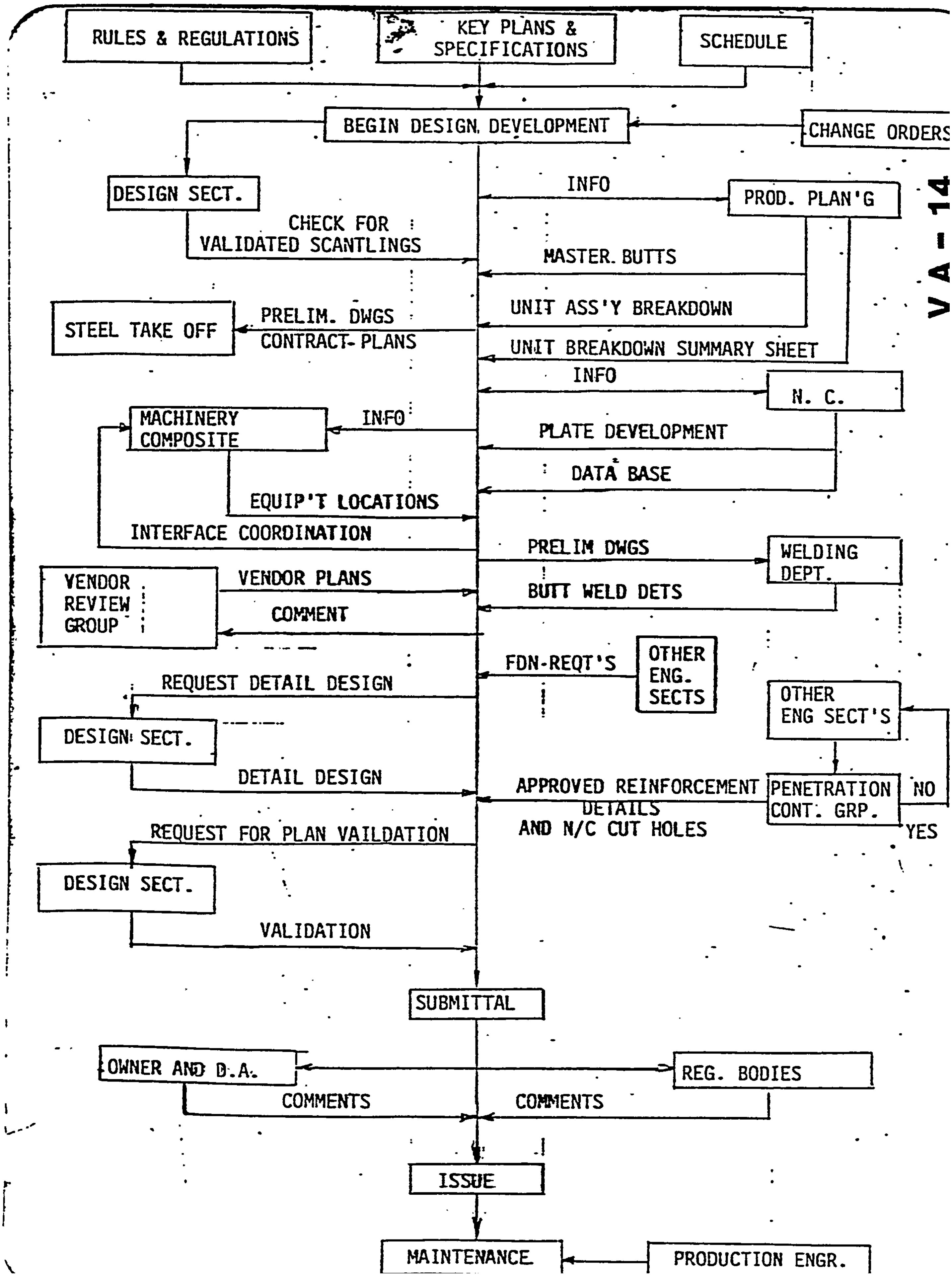
SIZE	REVISION	DWG NO	
C		CI-15	05-00-04

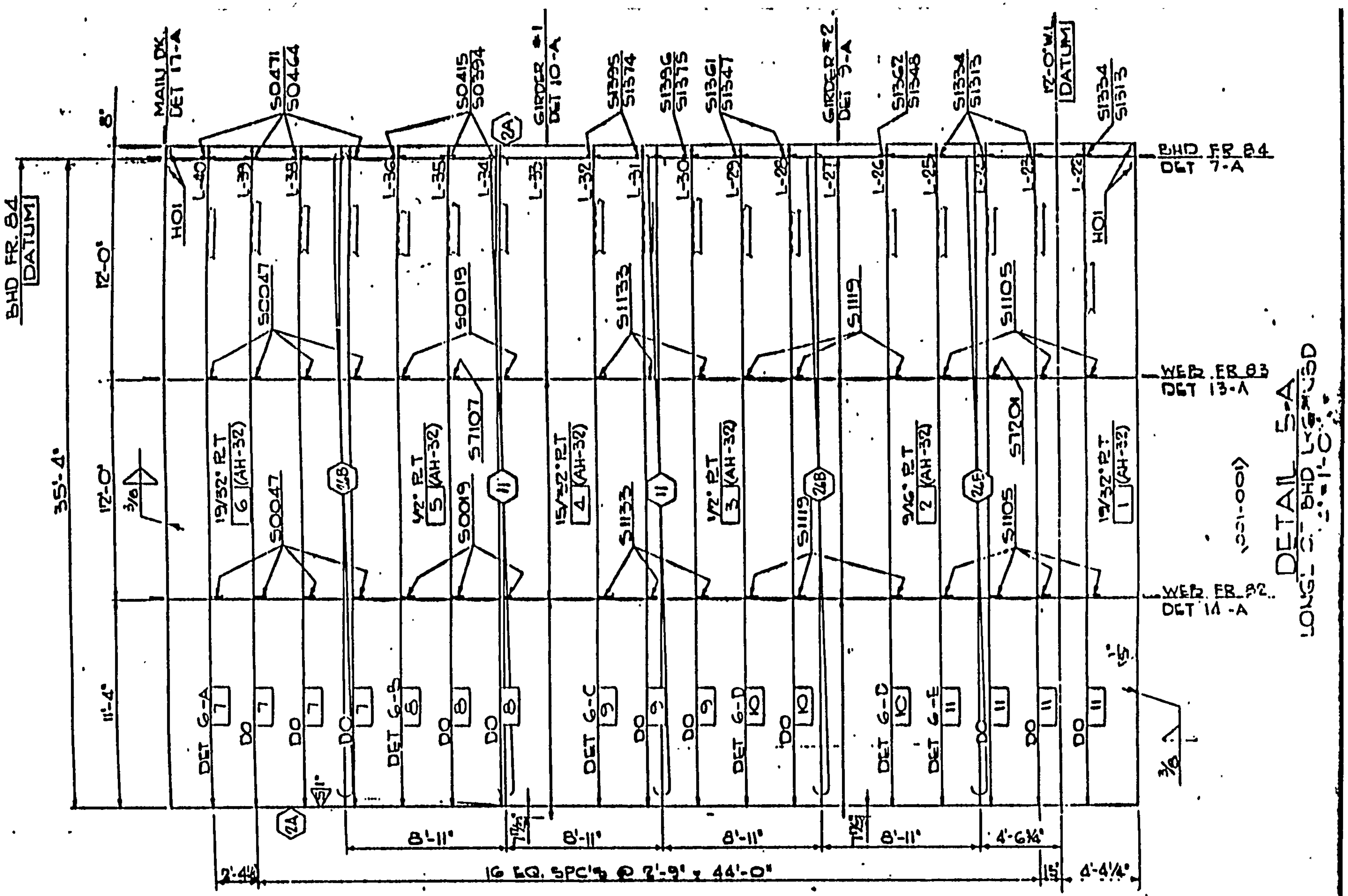
VA-13

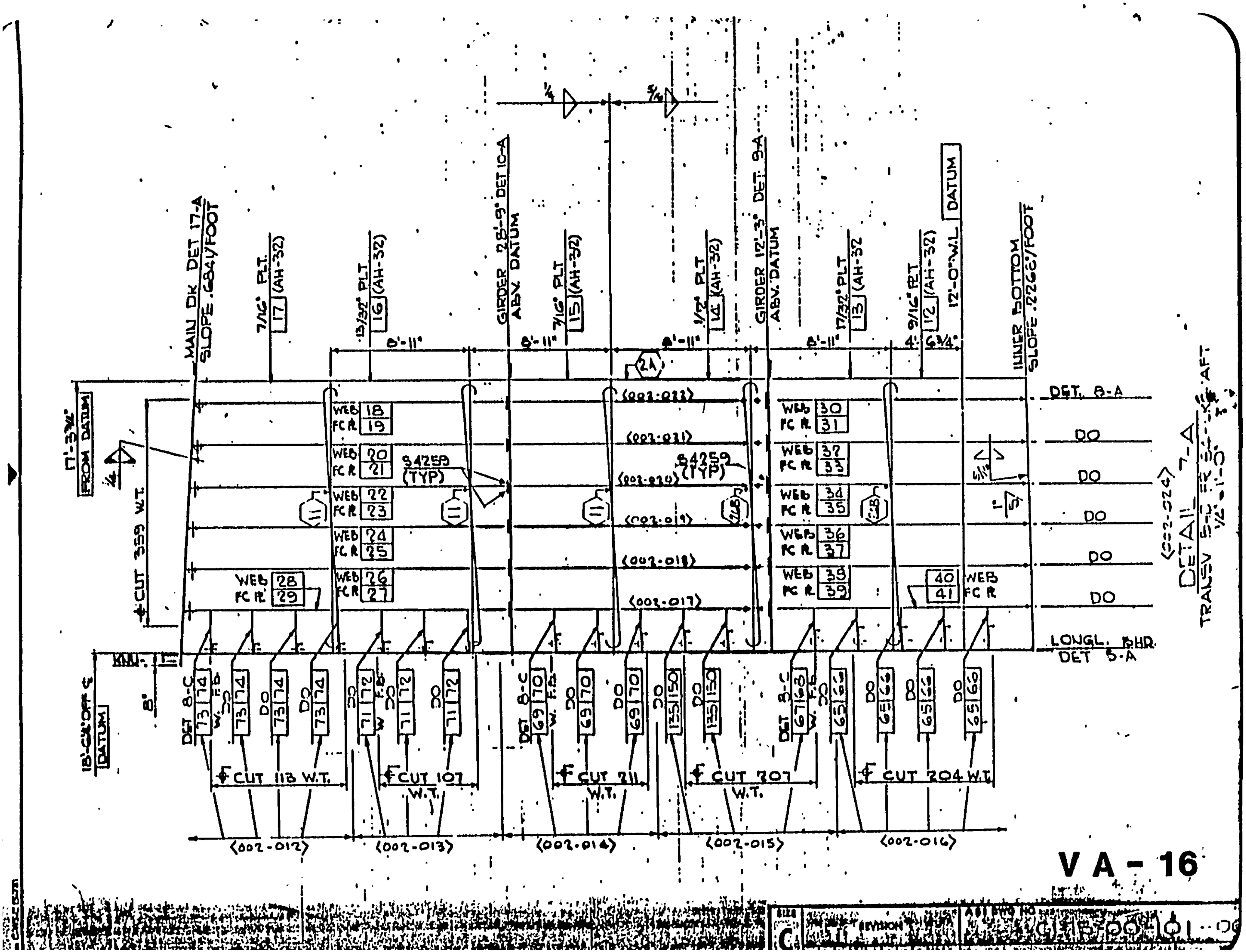


GO
READ CONTRACT SPECS & REVIEW PLANS
LIST MATERIAL
H.S. FOUNDATIONS & REVIEWS FOR OTHER SECTS
H.S. REQUESTS FROM CONTRACT PLANS & SPECS
H.S. DEVELOPS ON WORKING PLANS
PROD SCHE DATE
PLAN SC
TIMATED OCUREMENT AD TIMES
RQN. SECT.
INITIATE REQUESTS
CHECK REQUISITIONS
WORKING PLAN DEVELOPMENT
CHASING
REVIEW QUOTATIONS
PROCUREMENT SKETCHES
NDORS
INFO
PRELIMINARY VENDOR PLAN REVIEW
PLANS
RQN. & OTHER G. SECTIONS
ACTION
NER & SIGN AGENT
ACTION
REVIEW COMMENTS
COMMENT
DORS
DIRECTION
RQN & ER SECTIONS
PLANS
COMMENT
FINAL VENDOR PLAN REVIEW
VENDOR
ASSESS & COORDINATE
PRODUCTION PROBLEMS
OWNER DEFICIENCIES
RESOLUTION

VA-14


RULES & REGULATIONS
KEY PLANS & SPECIFICATIONS
SCHEDULE
BEGIN DESIGN DEVELOPMENT
CHANGE ORDERS
DESIGN SECT.
INFO
PROD. PLAN'G
CHECK FOR VALIDATED SCANTLINGS
MASTER BUTTS
UNIT ASS'Y BREAKDOWN
STEEL TAKE OFF
PRELIM. DWGS
CONTRACT PLANS
UNIT BREAKDOWN SUMMARY SHEET
INFO
N. C.
MACHINERY COMPOSITE
INFO
PLATE DEVELOPMENT
DATA BASE
EQUIP'T LOCATIONS
INTERFACE COORDINATION
PRELIM DWGS
WELDING DEPT.
VENDOR REVIEW GROUP
VENDOR PLANS
BUTT WELD DETS
COMMENT
FDN-REQT'S
OTHER ENG. SECTS
REQUEST DETAIL DESIGN
OTHER ENG SECT'S
DESIGN SECT.
DETAIL DESIGN
APPROVED REINFORCEMENT DETAILS AND N/C CUT HOLES
PENETRATION CONT. GRP.
NO
YES
REQUEST FOR PLAN VAILDATION
DESIGN SECT.
VALIDATION
SUBMITTAL
OWNER AND D.A.
REG. BODIES
COMMENTS
COMMENTS
ISSUE
MAINTENANCE
PRODUCTION ENGR.


DETAIL 5-A
LONG'L BHD LKG FWD
BHD FR. 84
DATUM
MAIN DK.
DET 17-A
GIRDER #1
DET 10-A
GIRDER #2
DET 9-A
12'-0" W.L.
DATUM
BHD FR 84
DET 7-A
WEB FR 83
DET 13-A
WEB FR 82
DET 14-A
35'-4"
12'-0"
12'-0"
11'-4"
8'-11"
8'-11"
8'-11"
8'-11"
4'-6 3/4"
16 EQ. SPC'S @ 2'-9" = 44'-0"
2'-4 1/4"
4'-4 1/4"
19/32" P.T.
6 (AH-32)
1/2" P.T.
5 (AH-32)
15/32" P.T.
4 (AH-32)
1/2" P.T.
3 (AH-32)
9/16" P.T.
2 (AH-32)
19/32" P.T.
1 (AH-32)
DET 6-A
DET 6-B
DET 6-C
DET 6-D
DET 6-E
DO
SO047
SO019
S1133
S1119
S1105
S7107
S7204
SO471
SO464
SO415
SO394
S1395
S1374
S1396
S1375
S1361
S1347
S1362
S1348
S1334
S1313
H01


MAIN DK DET 17-A
SLOPE .6841/FOOT
7/16" PLT. 17 (AH-32)
13/32" PLT. 16 (AH-32)
GIRDER 28'-9" DET 10-A ABV. DATUM
7/16" PLT. 15 (AH-32)
1/2" PLT. 14 (AH-32)
GIRDER 12'-3" DET 9-A ABV. DATUM
17/32" PLT. 13 (AH-32
9/16" PLT. 12 (AH-32)
12'-0" W.L.
DATUM
INNER BOTTOM
SLOPE .2266/FOOT
8'-11"
8'-11"
8'-11"
8'-11"
4'-6 3/4"
17'-3 3/4" FROM DATUM
CUT 359 W.T.
WEB 18 FC R 19
WEB 20 FC R 21
WEB 22 FC R 23
WEB 24 FC R 25
WEB 26 FC R 27
WEB 28 FC R 29
WEB 30 FC R 31
WEB 32 FC R 33
WEB 34 FC R 35
WEB 36 FC R 37
WEB 38 FC R 39
40 WEB
41 FC R
S4259 (TYP)
S4259 (TYP)
<002-022>
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<002-018>
<002-017>
DET. 8-A
DO
DO
DO
DO
DO
LONGL. BHD
DET 5-A
DETAIL 7-A
TRANSV 5-5
1/2" = 1'-0"
18'-6" OFF ℄ DATUM
KNU.
DET 8-C
CUT 113 W.T.
CUT 107 W.T.
CUT 211 W.T.
CUT 307 W.T.
CUT 204 W.T.
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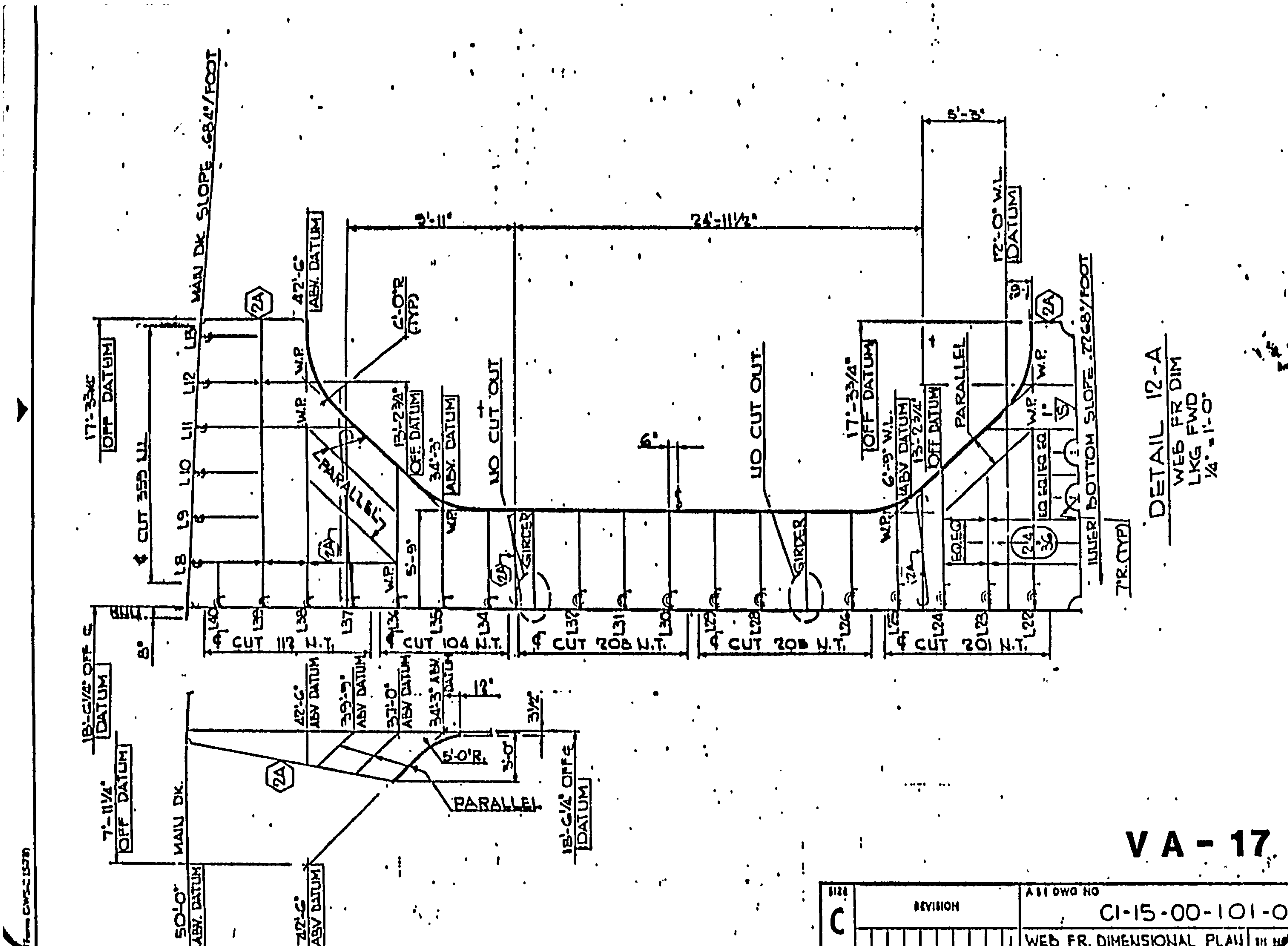
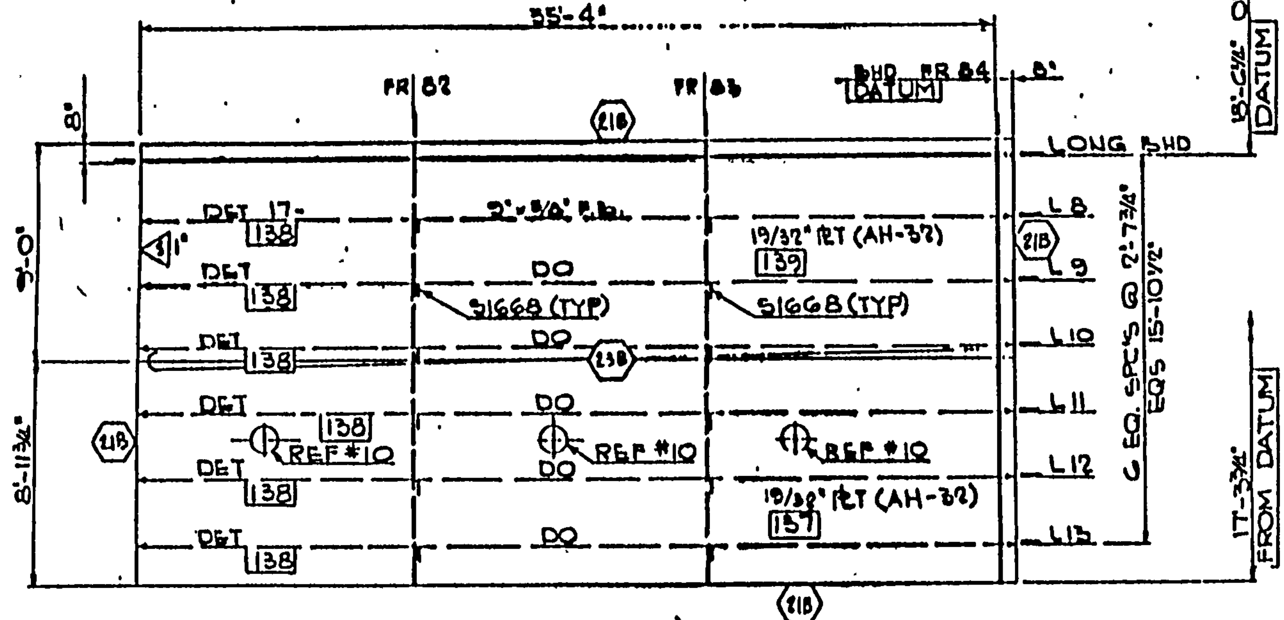
<002-013>
<002-014>
<002-015>
<002-016>

VA - 16

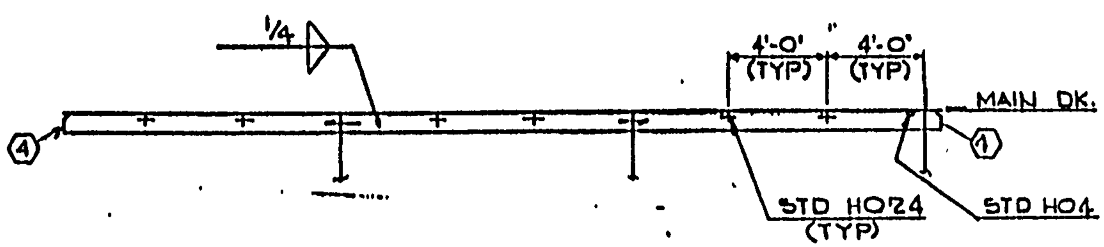


VA - 17

SIZE	REVISION	ABS DWG NO
C		C1-15-00-101-00
		WEB FR. DIMENSIONAL PLAN



DETAIL 17-A
MAIN DECK
1/4" = 1'-0"



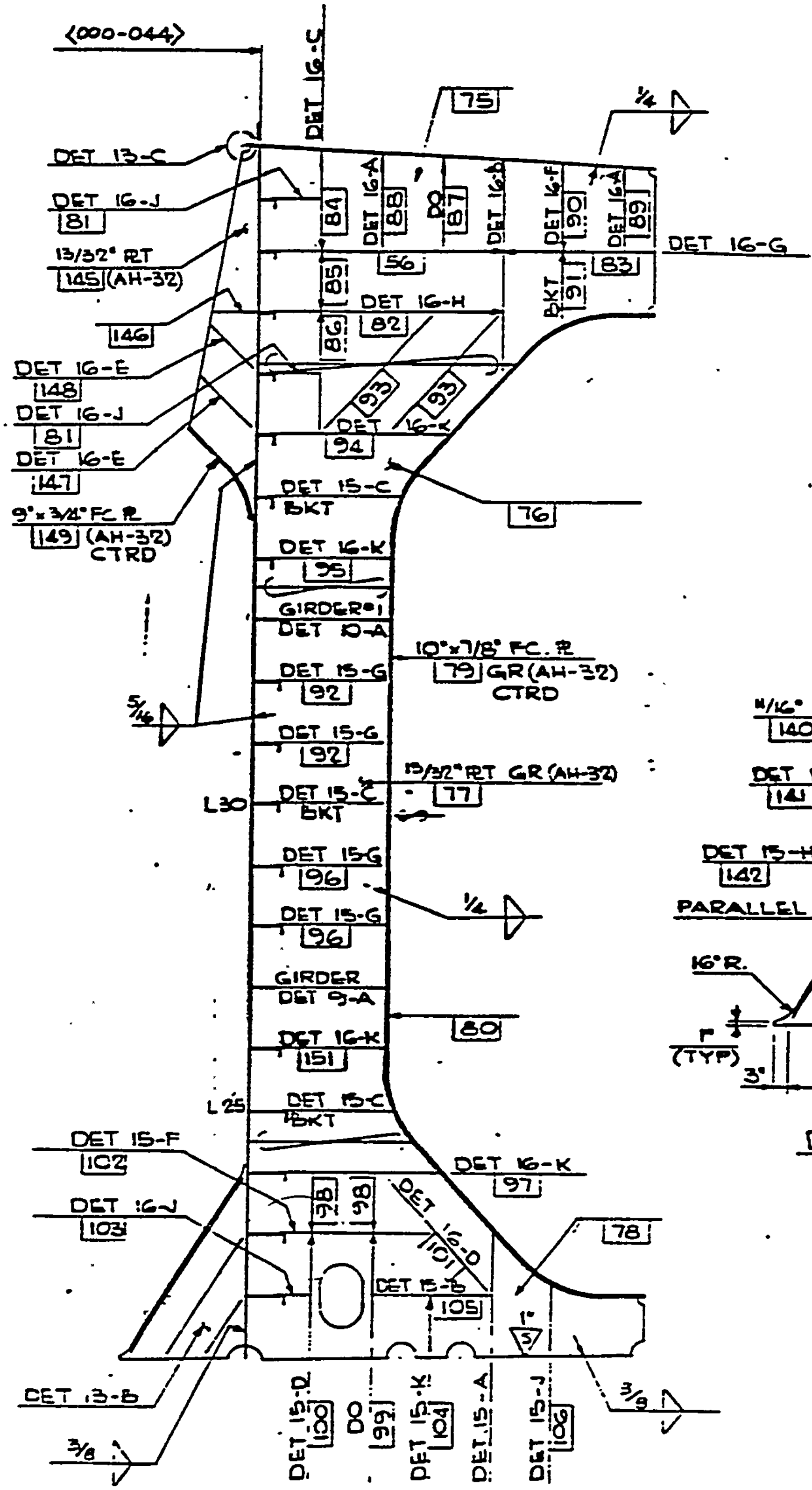
DETAIL 17-B
1/4" = 1'-0"

ALL MATERIAL AH-32

VA - 19

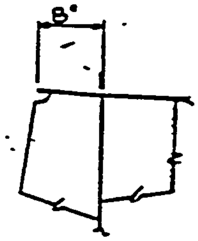
ALL ATHWARTSHIP DIMENSIONS ARE MEASURED ALONG A PLANE PARALLEL TO BASE LINE
MAIN DK LONGLS ARE NORMAL TO BASE LINE.

SIZE	REVISION	AH DWG NO
		C1-15-00-101-004

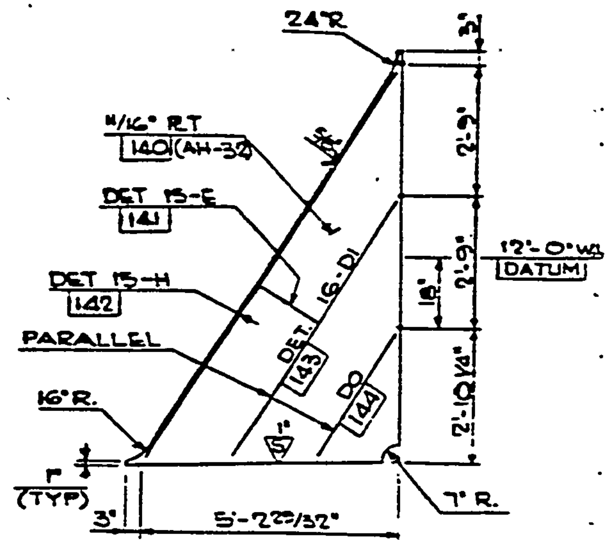


⟨003-028⟩

DETAIL 13-A
WEB FR 33
LKG =WD



DETAIL 13-C
1 1/2" = 1'-0"



⟨000-045⟩

DETAIL 13-B
1/2" = 1'-0"

DESIGN ENGINEERING FOR ZONE OUTFITTING
AVONDALE SHIPYARDS, INC.

MECHANICAL DESIGN SECTION

DESIGN ENGINEERING FOR ZONE OUTFITTING
MECHANICAL DESIGN SECTION

I. INTRODUCTION

The Mechanical Engineering activities at AS I are divided into two (2) principal groupings, one being the Mechanical Design Group which is responsible for the preparation of piping diagrams and procurement of most mechanical equipment, and the other being the Mechanical Machinery Group which prepares detailed fabrication drawings for machinery such as shafting systems, independent tanks, reach rods, and exhaust piping systems.

11. MECHANICAL DESIGN GROUP

From a viewpoint of unit and zone outfitting methods, the Mechanical Design Group has been relatively unaffected due to the requirements of our revised shipbuilding technology. Those items which have been incorporated in this area are a more condensed schedule which designates virtually every diagram and material list as a key plan and, therefore, requires their completion prior to the end of the key plan stage and our format of presentation for all diagrams which employs the vessel arrangement as the background and locates the diagrammatic as close to intended routing as possible.

It is virtually a necessity in the preparation of unit-type piping arrangement drawings to get this added guidance from the system designer on the diagram. It has been additionally discussed that the piping diagrams should denote unit boundaries and clearly indicate within which unit equipment or valves should be located. This added scope of refinement has been rejected to date, and I would expect will continue to be absent on diagrammatic for two principle reasons. Firstly, this added locating information, done during the initial design stage, would be too restrictive to the piping designer and would create additional effort to keep the diagram up to date with the actual arrangement. Secondly, as I alluded to during my comments on key plans this morning, this added work, which is really foreign to a mechanical system design engineer, would slow the process of issuing the diagrams which are essential at that point in time for piping arrangement and and material procurement activities.

Although not totally germaine to our implementation of unit and zone outfittinG concePts, we have over the Past several years significantly increased the listing of information and data on our piping system diagrams and find that the high level of completeness of these design documents is essential to effective development by the piping designers.

III. MECHANICAL MACHINERY GROUP

The Mechanical Machinery Group bears several identities in the implementation of unit and zone outfitting conepts. In their role of a design section for such tasks as piping stress analysis and shafting arrangement caclulations, they function much the same as the Mechanical Design Group. In the role of developing working drawings for major pieces of machining which ASI fabricates in specialized and dedicated locations, the format and presentation of their yard plans are much the same as in the past, except that the final fabricated assembly receives an identifying pallet code. Examples of these items are: propulsion shafting, propellers, line shaft bearings, and other major equipment which individually appear as events on production planning schedules. In the Machinery Machinery Group's role of developing yard plans for exhaust piping systems, tank level indicating systems, independent tanks, reach rods, cargo pump foundations and guides, etc., they have incorporated all aspects of the unit and zone outfitting concepts. As the bulk of these drawing requirements are a combination of piping and outfitting crafts, these techniques will be more adequately explained in the following presentation. The underlying concept during the detailing of the yard plans is to locate as much equipment on unit as possible, and items with which this is now being accomplished include the following:

reach rod bearing brackets;

shaft handling lifting eyes;

shaft brake foundation;

tank level indicator stools and mounting pads;

- deepwell cargo pump guide vanes;

- bow thruster shaft bearing stools;

exhaust piping for main engine, diesel generator engines, boiler , incinerator.

DESIGN ENGINEERING FOR ZONE OUTFITTING
AVONDALE SHIPYARDS, INC.

PIPING AND HVAC SECTION

DESIGN ENGINEERING FOR ZONE OUTFITTING
PIPING AND HVAC SECTION

I. INTRODUCTION

The advent of zone outfitting technology has had many far--reaching effects on the operations of the Piping and HVAC Section. This is due to the fact that perhaps no other Engineering Section was as "systems oriented" as was Piping and HVAC prior to zone outfitting. As is obvious to you by now, zone outfitting abolishes for most applications the systems orientation of traditional shipbuilding techniques and replaces it with a zone or unit oriented approach.

Drawing preparation has been complicated in that there are more drawings to be produced and they are more complex than were systems drawings. Gone are the days when designers could specialize in a handful of systems that they could work from job to job. Now a designer must be knowledgeable about many systems, because all piping systems within a given unit must be worked as the particular unit drawing is being prepared.

Gone also are the days when designers had only to know the basics about production techniques that were to be used. Now a designer must become intimately familiar with the particular method of fabrication to be used on each unit he is to work. The document used to instruct lhgineering as to Production’s fabrication methods is the "Unit Breakdown Summary Sheet and Construction Procedure." This document provides Engineering with step-by-step details about each unit’s construction sequence. This, then, allows Engineering to properly code each piece of equipment - pipe, fittings, etc. - so that it arrives at the correct job site when required by Production.

The need for Engineering familiarity with Production techniques has led to a much closer bond between the two departments. Meetings are held on a regular basis, during which ideas can be exchanged and drawings can be reviewed well in advance of planned construction starts. It is estimated that many Production manhours will be saved as a result of these meetings.

The impact of revision activity has been greatly increased due to the increased number of drawings. A change in a pipe size on a particular diagram could have an effect on numerous unit drawings and their P/D’s, L/M’s, and H/L’s; whereas, in the past, only the system drawing affected by the diagram would have been altered. Therefore, it is critical that design changes be kept to an absolute minimum.

My discussion this afternoon will focus on the preparation of piping drawings to accommodate zone outfitting. Much of what is said of these drawings is applicable also to HVAC and Mechanical Machinery drawing preparation, as previously alluded to. Piping development effort is subdivided into the following areas for a typical tanker:

- Machinery Composite
- Machinery Space, Tank Heating Coils and Innerbottom
- Outside Machinery Space and Main Deck Racks
- Machinery Package Units
- Quarters

We will look at the first four areas with the knowledge that the same techniques apply to quarters piping development. we will also look at the way in which the preparation of Piping Details (P/D's) and Lists of Material (L/M's) have been affected by zone outfitting technology.

II. MACHINERY COMPOSITE

For over twenty years, Avondale's Machinery Composite Group has provided the primary design for machinery space and main deck arrangements. These composites are not merely interference checks, but are used to provide the arrangement groups with completely routed sy"stems for working drawing development.

Basically, the procedure for machinery composite development has remained the same with zone outfitting. The composites are done at 1/2" to 1" scale, depending on area, and are divided into the required plan and section views to clearly represent the area depicted. The composites show all systems within 'the machinery space including piping, HVAC and wireways, as well as outfitting items such as ladders, gratings, and so on. GRAPHS PH-lA through PH-lC are various views of a machinery space composite now being developed. The major difference between composites now and before zone outfitting is the manner of presentation to the arrangement group. Before, an entire system was routed on composite and then forwarded to the arrangement group for development into working drawings. Now, the composite group routes all the systems within a particular unit and then forwards that unit to the arrangement group.

Since machinery spaces are developed from the lower levels on up, the obvious problem with zone outfitting is to be certain that all systems in a given unit have been routed piror to issue to the arrangement group. Avondale's answer to this problem is what we call the Advanced Design Composite Study or ADCS. The ADCS is a 1/2" scale, single line routing of all systems in the machinery space, main deck, or other congested area of the vessel. It should take approximately six weeks for the "preliminary" ADCS to be developed for a vessel like the Exxon multi-product carriers Avondale is currently building, and approximately three months for the final ADCS to be developed. This, of course, assumes that vendor information and contract drawings are ready at the start of ADCS development. It also assumes that top notch designers are available to handle the assignment. GRAPHS PH-lD and PH-1E are two views of the ADCS which was done on the above-mentioned Exxon carriers.

Another difference between the traditional and the new composites is that now the unit breaks are clearly shown on the composites. This is to ensure that machinery is not located on the break lines and to ensure that allowance is made for flanging make-up pipe pieces to bridge unit breaks after erection.

III. MACHINERY SPACE, TANK HEATING COILS AND INNERBOTTOM

It is a long standing procedure at Avondale to prepare arrangement drawings from reduced photographic copies of machinery composites. This procedure is being maintained for the drawing being prepared for zone outfitting. The task is, however, more difficult than in the past. With systems drawings, the systems not being developed could be subdued and the subject system highlighted. However, with zone outfitting, all the systems in a given unit must be highlighted. In especially congested areas, such as the machinery space lower level, this task is almost impossible to accomplish. What must be done in these situations is to present a number of views of the same area with each view depicting a certain number of systems for clarity.

GRAPH PH-2 provides some notion of the difficulty of depicting all the necessary data such as penetration codes, piping detail numbers, dimensions, and so on. This is not, of course, a problem unique to Avondale, but it is compounded by having to depict all systems within a given area. GRAPHS PH-3 and PH-4 are two section views of the machinery space area. Note how the various systems involved are called out on each drawing and how the lines of demarcation for each unit are shown. Note on GRAPH NO. PH-4 how the machinery package units for the Inert Gas Scrubber Pump, the E.R. Bilge and Ballast Pump, and the Main and Harbor S.W. Pump are shown in dotted line. These and other package units are detailed on individual package unit drawings as will be discussed a bit later.

GrAPH PH-5 is another view of the machinery space area. Note here that certain piping details are called out as adjusting pieces.

gRAPH PH-6 is a tank heating coil assembly. The Piping Section is called on to design not only the heating coil itself but also the structure used to support it. This blending of Engineering disciplines is really a hallmark of the zone outfitting philosophy which emphasizes concentrating as much design effort in a given group or section as is technically possible. GRAPH PH-7 is the detail of the pipe rack structure.

IV. OUTS IDE MACHINERY SPACE AND MAIN DECK RACKS

The outside machinery space drawings are prepared similarly to the machinery space drawings, with the major difference being that they are prepared without benefit of design composites. The arrangement group must examine piping diagrams and develop the ADCS from which the arrangement drawing is then taken.

The main deck rack drawings for the present Exxon contract are quite different. Composites similar to those prepared for the machinery space area were done for the main deck, which was then divided into three zones with six to eight racks in each zone. Each rack contains sections of pipe together with the necessary supporting structure, walkways, and gratings. It is quite an improvement to assemble the rack completely outfitted and lift it in one piece aboard ship as opposed to the traditional procedure of assembling pipe structure on the ship and then adding the pipe, piece by piece. As with the tank heating coil drawings discussed a few minutes ago, the Piping Section is responsible for developing the rack structure, as well as the pipe routing and detailing. The Outfitting Section provides the ladder and grating drawings for the racks.

-PHS PH-8, PH-9, PH-10, PH-11, and PH-12 are plan views of main deck composite sheets. The views are between frames 84 and 81 and are cut at five different levels for clarity.

CRAPH PH-13 is a section view of main deck composite sheets.

GRAPH PH-14 is the title sheet from a main deck rack working drawing.

GRAPH PH-15 is the rack structure. Note the structural detail code numbers such as "SD-66S-1." These details are depicted in a separate structural detail booklet. GRAPH PH-16 is the title sheet for a typical structural detail booklet. GRAPHS PH- 17, PH-18, and PH-19 are typical structural detail booklet sheets.

GRAPHS PH-20 and PH-21 are the piping arrangement for the main deck rack booklet that we are looking at.

On our Exxon contract, we have used model engineering rather extensively to depict the main deck rack development. GRAPHS PH-22 through PH-30 are photos of the main deck rack model at Avondale's Model Shop. The model is composed of the assembled racks and can be broken down to duplicate the planned construction technique. Aside from assisting Avondale Engineering, the model has already proven to be a real benefit for Production, owners, and regulatory bodies.

V. MACHINERY PACKAGE UNITS

GRAPH PH-31 is a list of the machinery package units which Avondale is designing and constructing for the Exxon contract.

Although Avondale has built package units in the past, this current effort is the most comprehensive to date and certainly the most successful. One of the major factors in the success of the package unit program has been the construction of the Machinery Package Unit Assembly Shop, a large shop with overhead cranes, a clean environment in which to work and so on. The rapport that has been established between the shop foreman and Engineering personnel is excellent. A good many more engineering manhours beyond our original projection have been expended on package unit development; however, initial reports from the shop indicated that a production manhour savings in the neighborhood of 15% may be hoped for. Not bad for a first-effort.

There are two basic types of package units. First, there is the Custom Built type which is designed to suit certain conditions of the vessel being designed. These package units will differ from design to design and are usually found in congested areas such as the lower level of the machinery space. The Bilge and Ballast Pump Package Unit is a good example of this type of package unit. The other type of package unit is the standardized type such as the Fuel Oil Pump Package Unit. These package units are suitable for reuse on other jobs and are usually found in less congested areas such as the upper levels of a machinery space. Of course, the ultimate goal should always be to design package units such that they are reusable.

Like the main deck racks, the package unit drawings are self-contained and are produced completely by the Piping Section. Even ladders and gratings are done by the Piping Section. GRAPH PH-32 is the title sheet from the Bilge and Ballast Pump Package Unit.

GRAPH PH-33 is the Revisions and General Notes Sheet. Note the complexity and level of detail of the general notes.

GRAPH PH-34 is one of the Parts List sheets. There were four like this on this particular package. GRAPH PH-35 is a general arrangement of the subject package. Note the location key located in the lower left-hand corner. Also, note the gage board information, lifting information, gratings and ladders.

GU$PHS PH-36 and PH-37 are structural views and details.

GRAPHS PH-38 and PH-39 are piping arrangement views for the package unit.

GRAPH PH-40 contains information on ladders and gratings.

GRAPH PH-41 contains information on remote operators, gage boards and control instrumentation.

GRAPH PH-42 provides the information necessary for label plate installation.

Also, like the main deck racks, the package unit drawings on the Exxon contract have been prepared with the assistance of design models. These models have been extremely useful during the design phase in catching interferences and other problems that might otherwise have gone unnoticed. Their real value is being realized now, as Production consults them during actual package unit construction. The models are in a location close to the Package Uhit Assembly Shop and are used constantly.

GRAPHS PH-43 and PH-44 are photos from two views of the Fuel Valve Cooling Water Pumps package unit.

VI. PIPING DETAILS

Each unit, machinery package unit, and main deck rack contains a piping detail drawing (P/D). The procedure for producing P/D’s under zone outfitting has not changed a great deal from the traditional method with which these drawings were prepar ed. The major difference really is the addition of the pallet code number (see GRAPH PH-4S) and the attention that is paid to Pipe Shop work station routing and coating procedures. The routing and coating information is the result of a) adapting to Avondale’s new semi-automated Pipe Shop to accommodate zone outfitting technology, and b) the need for more accurate computer-aided scheduling required for zone outfitting. A word should be mentioned here about the importance of pallet coding. You can think of a pallet as a "bucket" which contains all items required at a certain location for Production to do a certain work package. This "bucket" is then given a name which we call a "pallet code." A required delivery date of the "filled bucket" at the job site can be determined by Production Planning, and from this date all other scheduling required for the items in the "bucket" can be determined.

GRAPH PH-46 is the cover sheet from a main deck rack drawing P/D, and GRAPH PH-47 is a typical sheet from that P/D. Note the pallet code number in the upper right-hand corner.

GRAPH PH-48 is another typical sheet from the same P/D. Again, note the pallet code number, and also note the coating code numbers.

GRAPHS PH-49, PH-50, and PH-51 are also from this P/D, but they differ from the sheets we have just seen in that they contain Pipe Shop routing information on the same sheet as the P/D spool, and these sheets have been prepared using CADAM, which is an automated drafting system being utilized at Avondale. The Pipe Shop routing is determined by a designer familiar with pipe fabrication who enters the information into a computer program called COPICS. Entered into this program is the shop routing, material listing and pallet codes. COPICS then can automatically schedule the work in the Pipe Shop in order that fabricating schedules are met for installation of the piping in the units and to level load the work in the Pipe Shop at the various work stations.

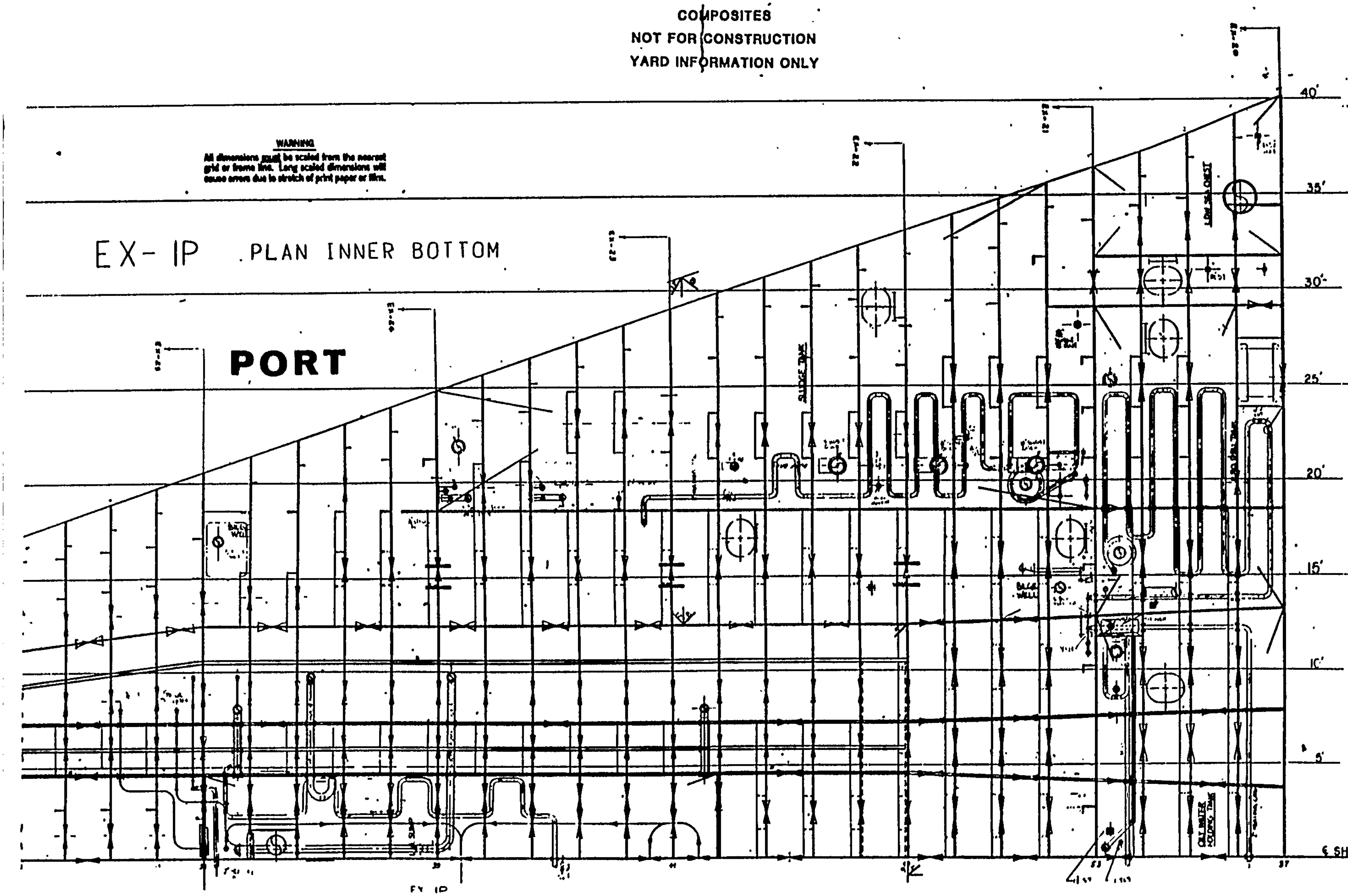
VII. LISTS OF MATERIAL

Separate lists of material are prepared for each unit and main deck rack. The procedure used now for generating the list of material (L/M) is almost identical to the procedure used prior to zone outfitting technology, with the exception that an L/M is prepared for each unit or rack and the L/M must contain the pallet code for each item.

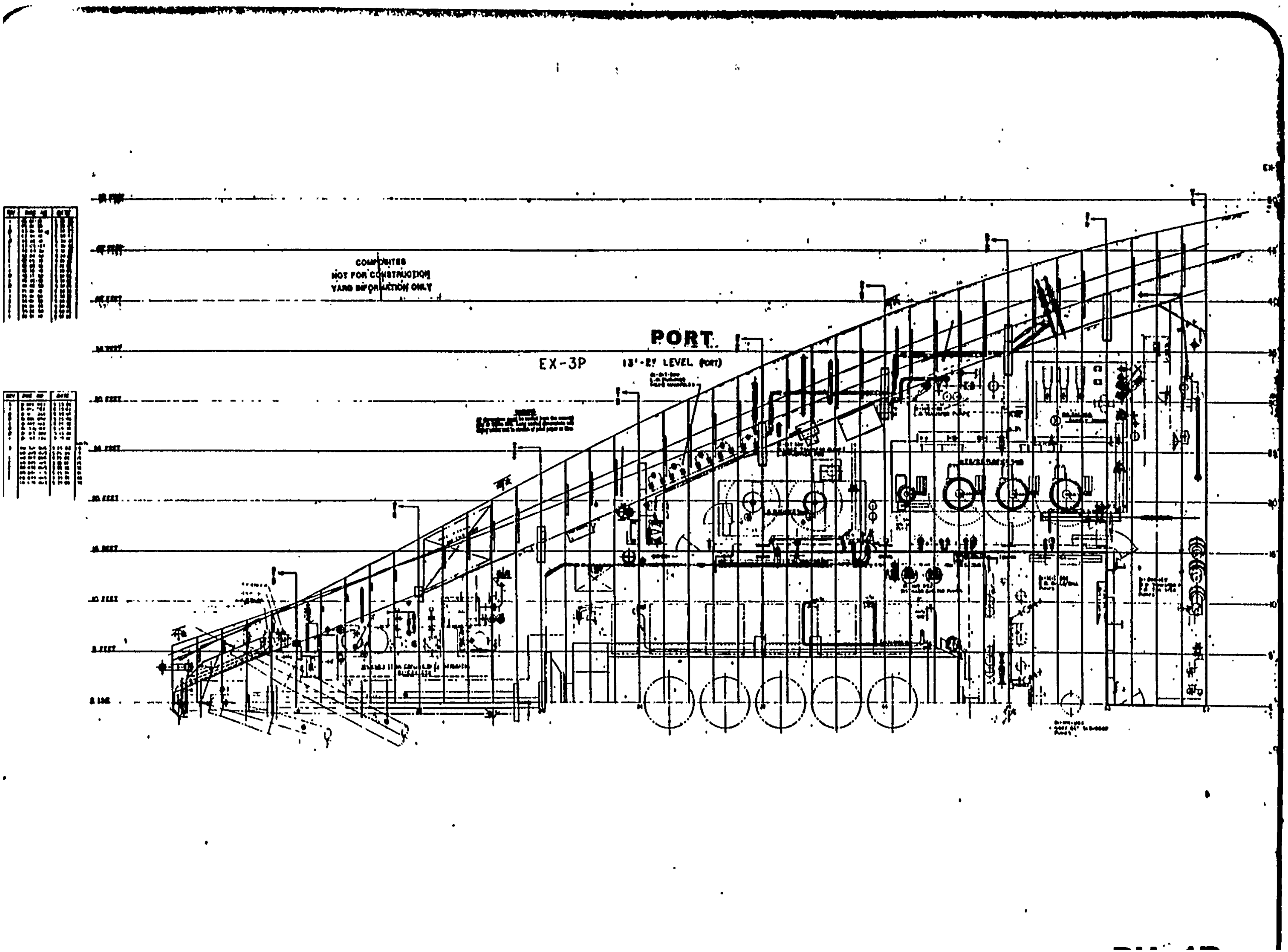
GRAPH PH-52 is the title sheet for a main deck rack drawing L/M, and GRAPHS PH-53 and PH-54 are typical sheets from that L/M. Note the pallet code for each item.

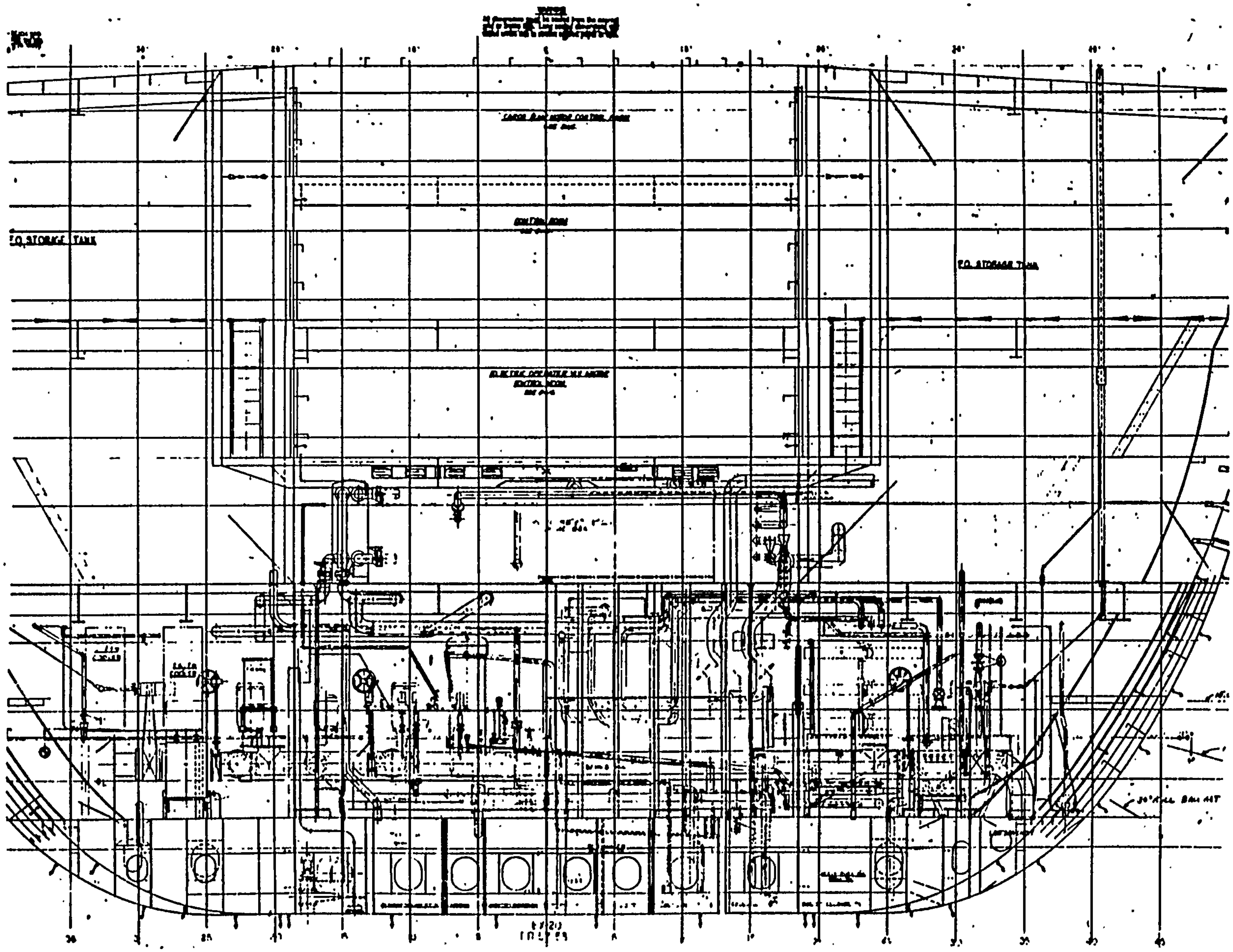
VIII. CONCLUSION

The Piping and HVAC Sections' entry into the realm of zone outfitting technology has been a true "trial by fire." .Not only did we and all of the other Engineering Sections have more to do than ever before, but we had less time to do it in. It was extremely difficult for us to estimate in terms of manhours what we would need in order to accomplish our assigned tasks. There have been budget overruns; however, we feel that the savings to be realized on the Production side will more than compensate for our additional expenditures.

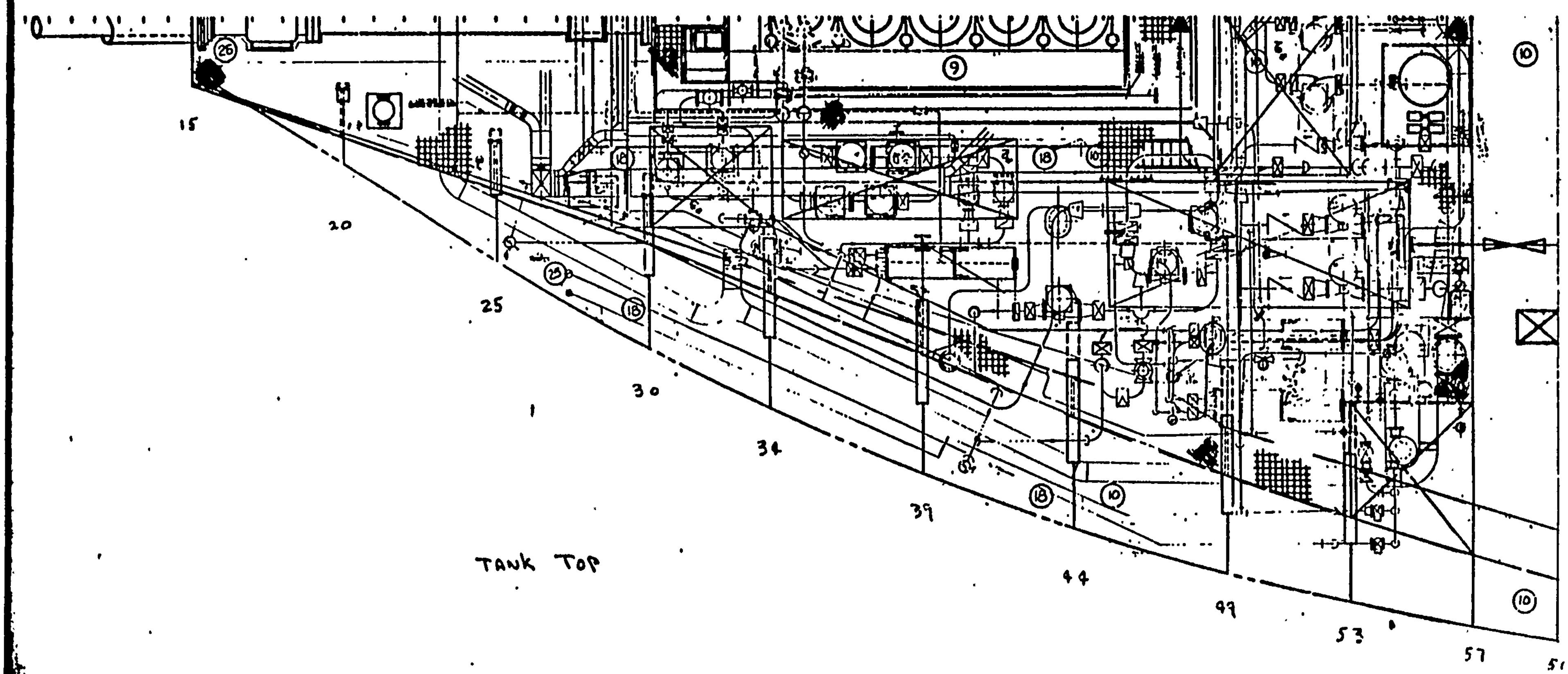

COMPOSITES
NOT FOR CONSTRUCTION
YARD INFORMATION ONLY
WARNING
All dimensions must be scaled from the nearest grid or frame line. Long scaled dimensions will cause errors due to stretch of print paper or film.
EX- IP PLAN INNER BOTTOM
PORT
40'
35'
30'
25'
20'
15'
10'
5'
℄ SHIP
SLUDGE TANK
EX IP

PH-1A

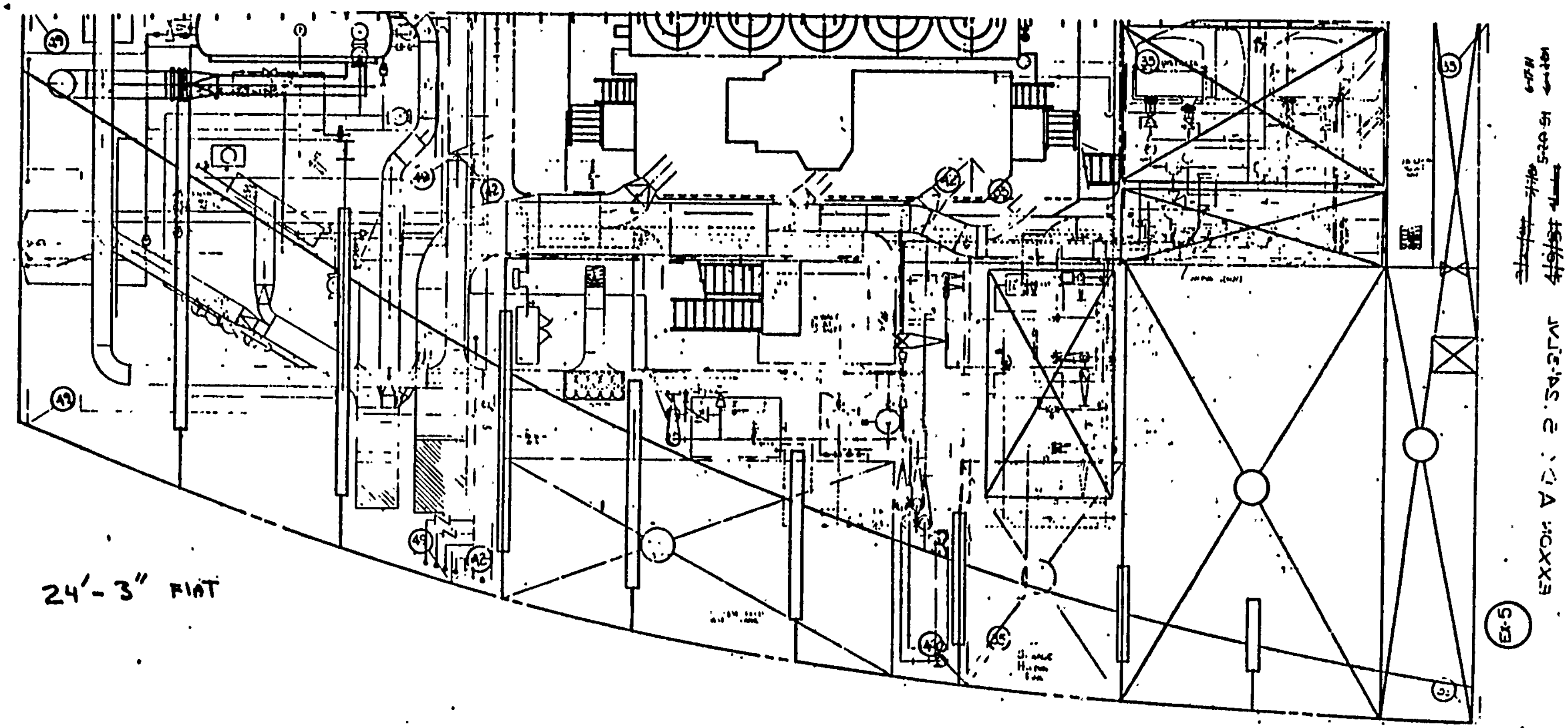

COMPOSITES
NOT FOR CONSTRUCTION
YARD INFORMATION ONLY
PORT
EX-3P
13'-27' LEVEL (PORT)



PH-1C

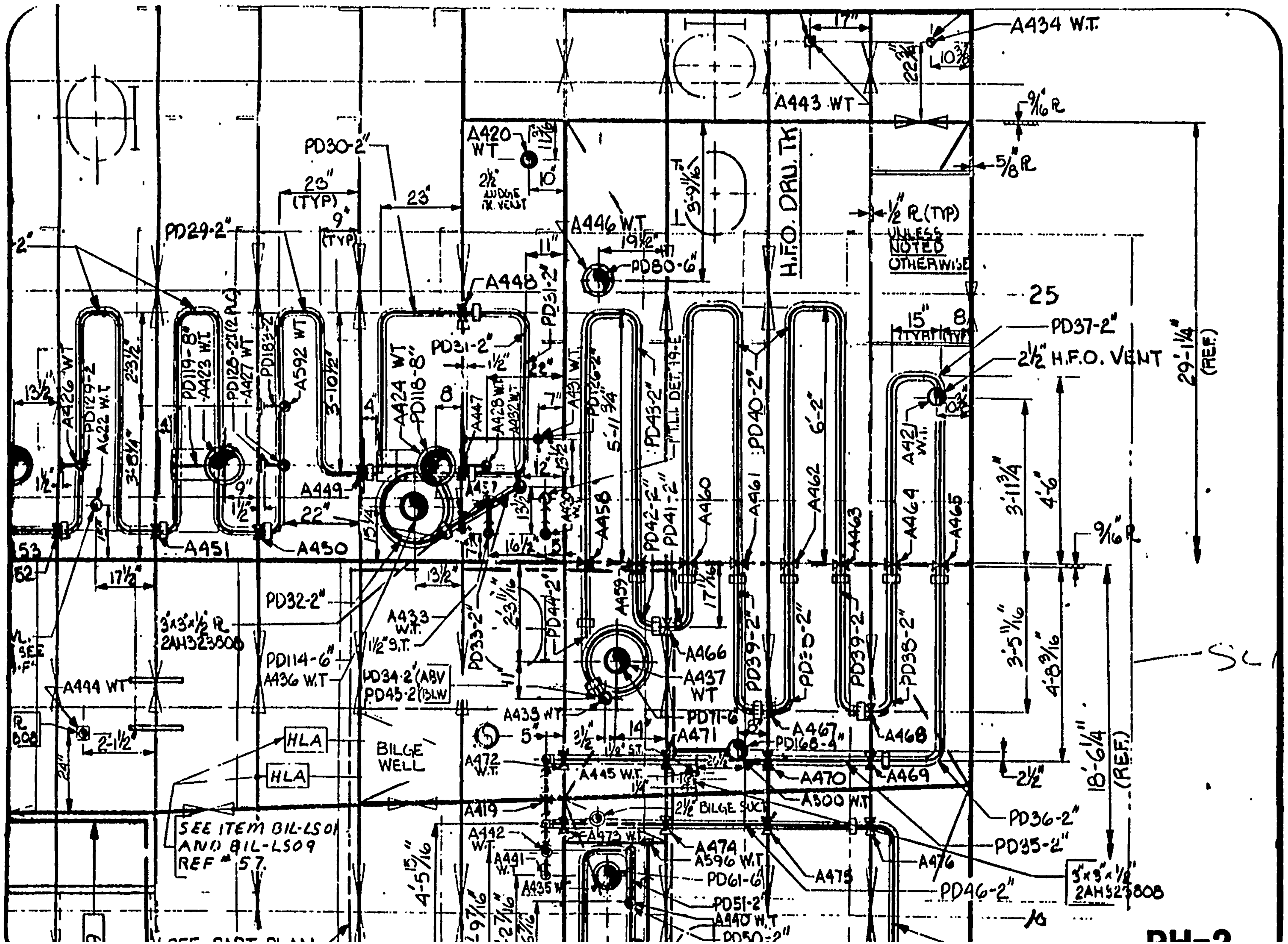


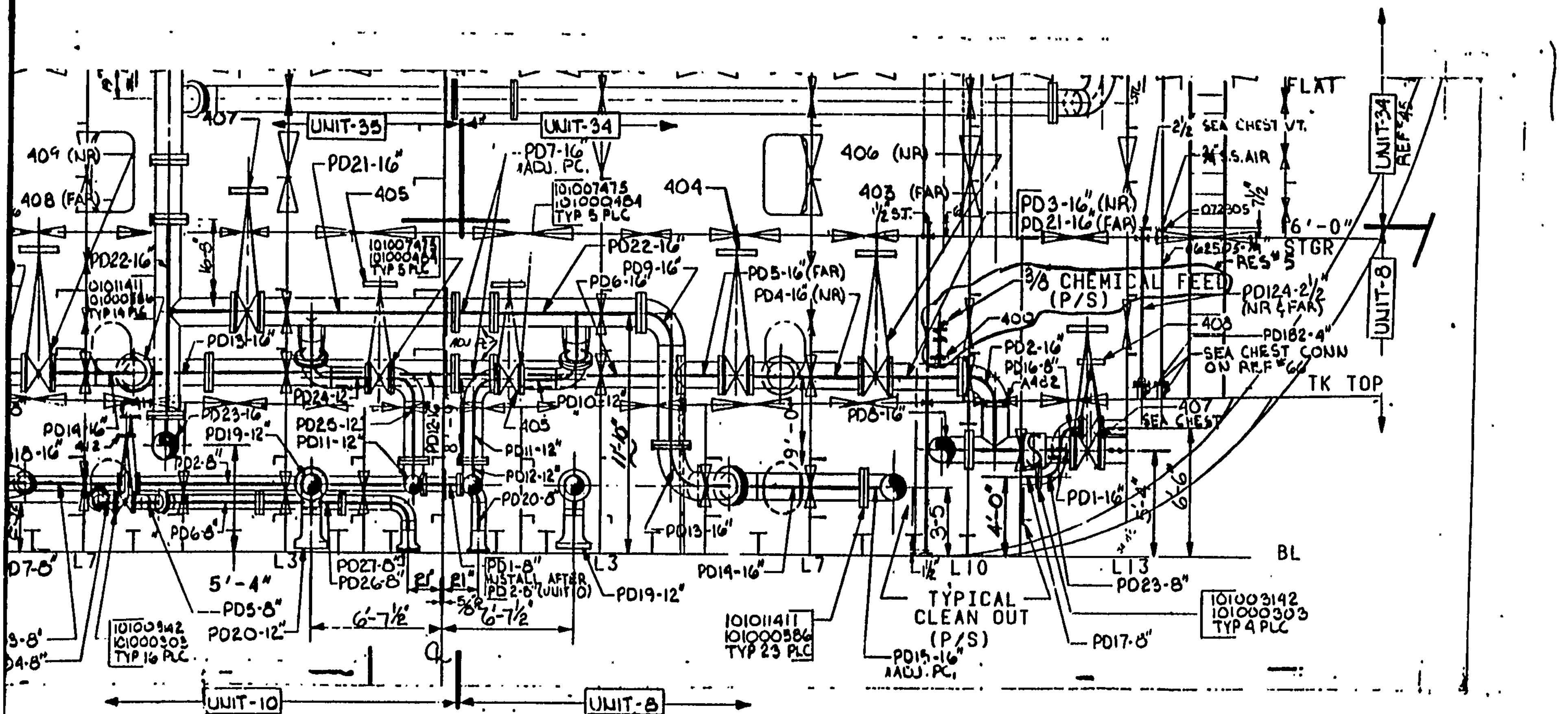
15
20
25
30
34
39
44
49
53
57
TANK TOP



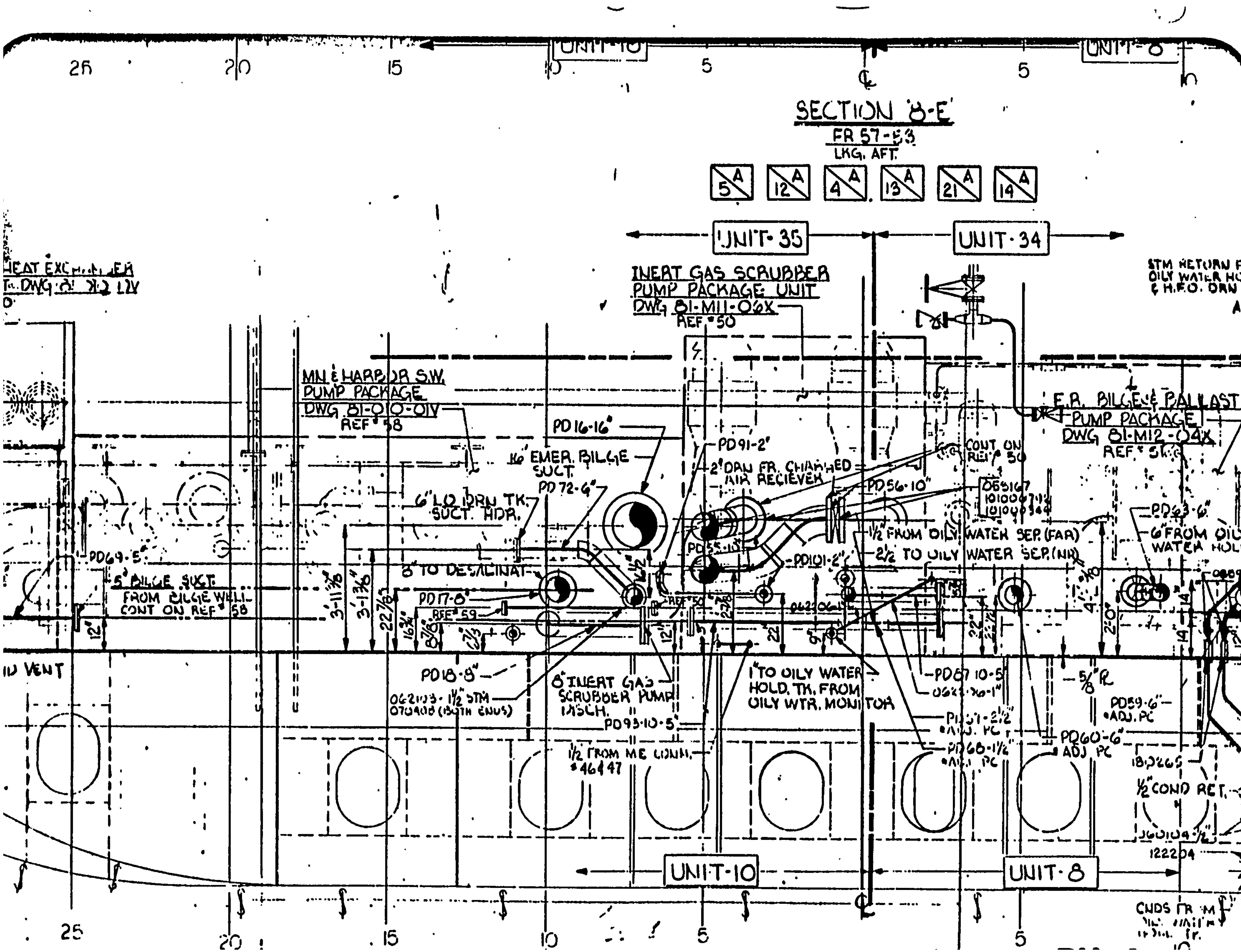
24'-3" FLAT

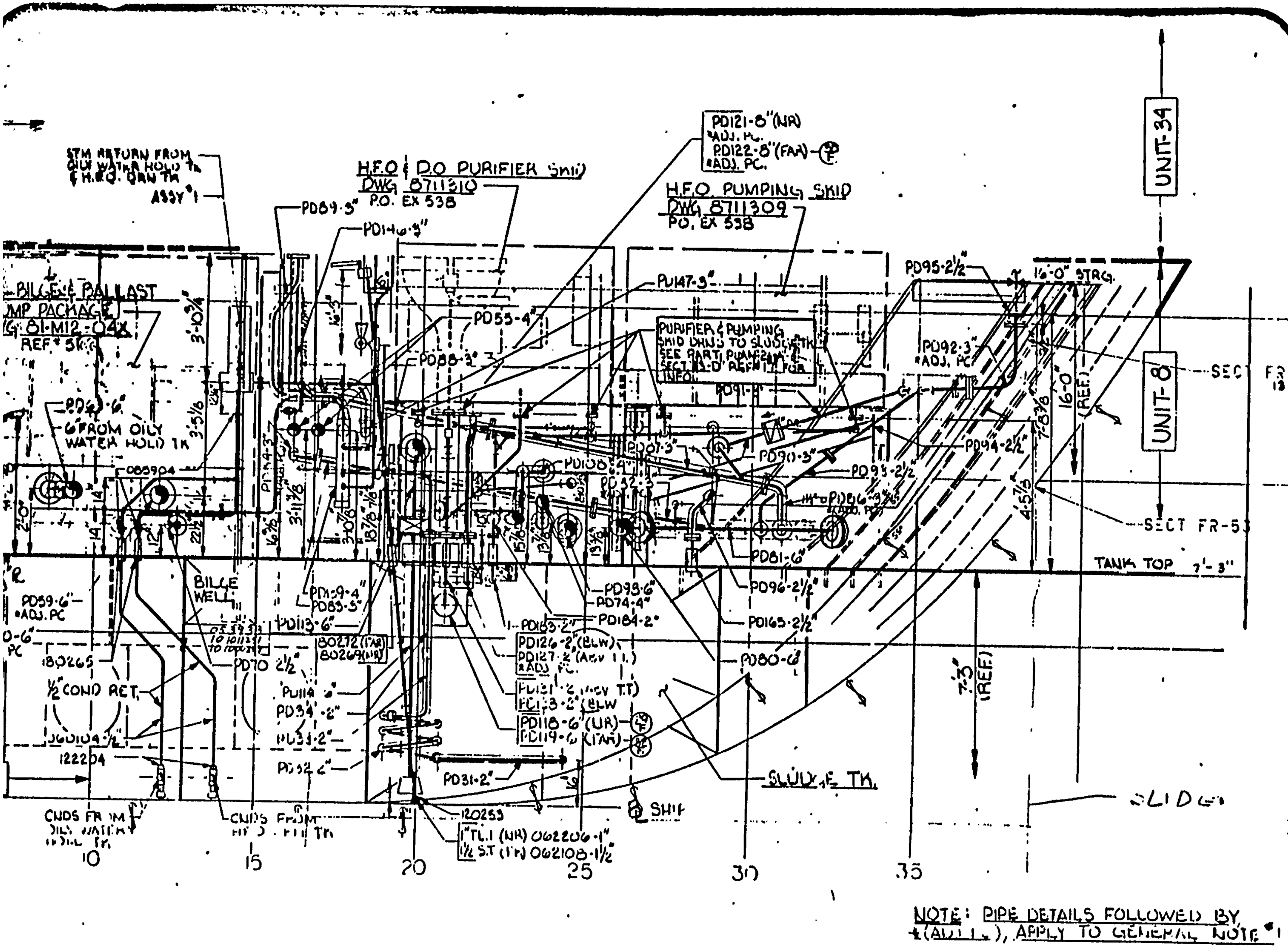
PH-1E

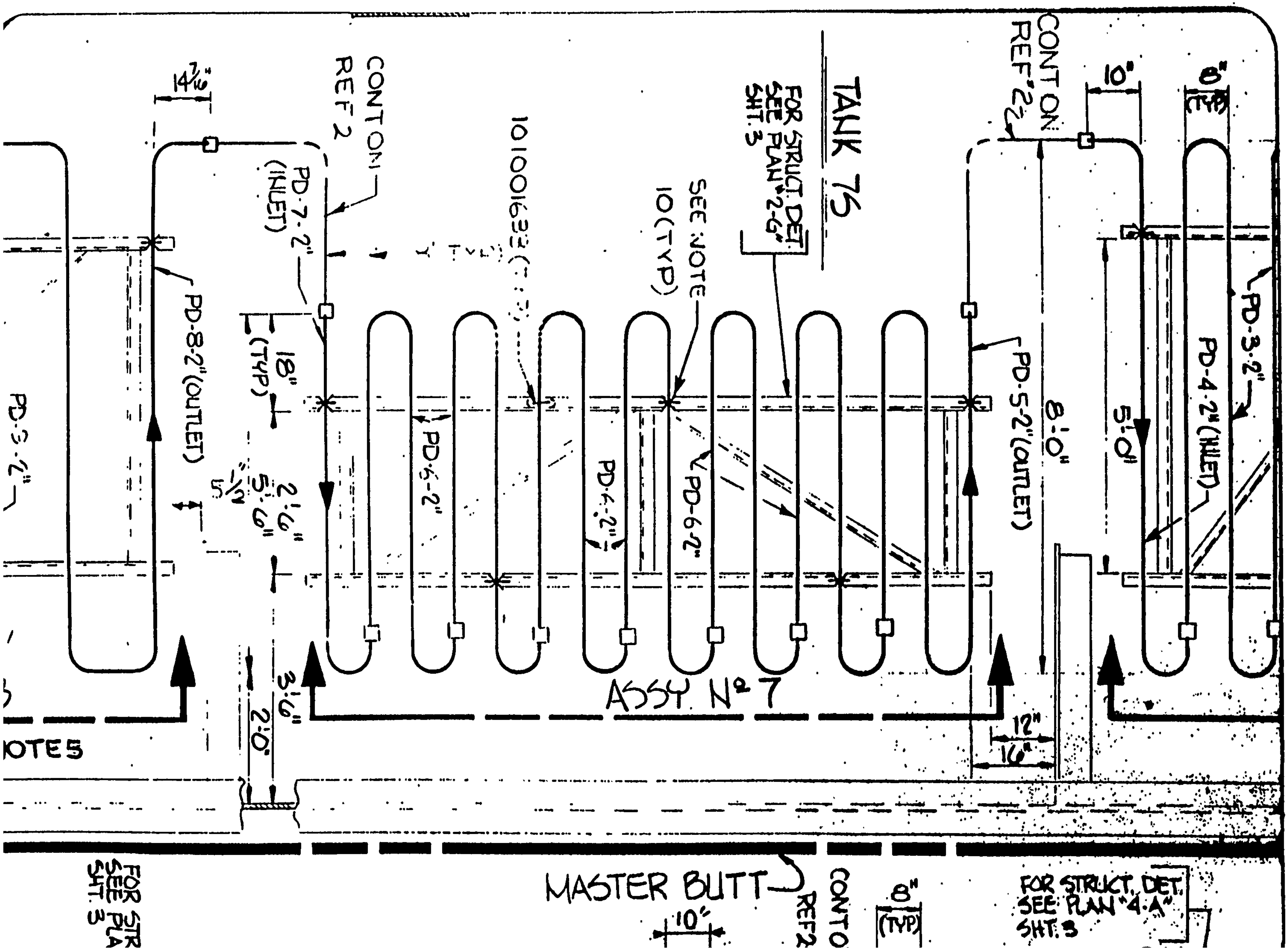

A434 W.T.
A443 W.T.
9/16" R
5/8" R
A420 W.T.
PD30-2"
23" (TYP)
23"
9" (TYP)
PD29-2"
A446 W.T.
PD80-6"
H.F.O. DRN. TK.
1/2" R (TYP) UNLESS NOTED OTHERWISE
A448
PD31-2"
25
PD37-2"
2 1/2" H.F.O. VENT
29'-1 1/4" (REF.)
A592 W.T.
A424 W.T.
PD118-8"
PD119-8"
A423 W.T.
A447
PD43-2"
PD40-2"
6'-2"
A421 W.T.
A449
A451
A450
PD42-2"
PD41-2"
A458
A460
A461
A462
A463
A464
A465
3'-11 3/4"
4'-6"
PD32-2"
3"x3"x1/2" R 2AH323808
A433 W.T.
1 1/2" S.T.
PD33-2"
PD44-2"
A459
A466
PD114-6"
A436 W.T.
PD34-2" (ABV)
PD45-2" (BLW)
A437 WT
PD39-2"
PD38-2"
PD35-2"
3'-5 11/16"
4'-8 3/16"
18'-6 1/4" (REF.)
A444 WT
A439 WT
PD11-6"
A467
PD168-4"
A468
A471
A472 W.T.
A445 W.T.
A470
A469
2 1/2"
HLA
HLA
BILGE WELL
A300 W.T.
A419
2 1/2" BILGE SUCT
PD36-2"
SEE ITEM BIL-LS01 AND BIL-LS09 REF # 57.
A442 W.T.
A473 W.T.
A474
A596 W.T.
A441 W.T.
PD61-6"
A475
A476
A435 W.T.
PD51-2"
A440 W.T.
PD50-2"
PD46-2"
3"x3"x1/2" 2AH323808



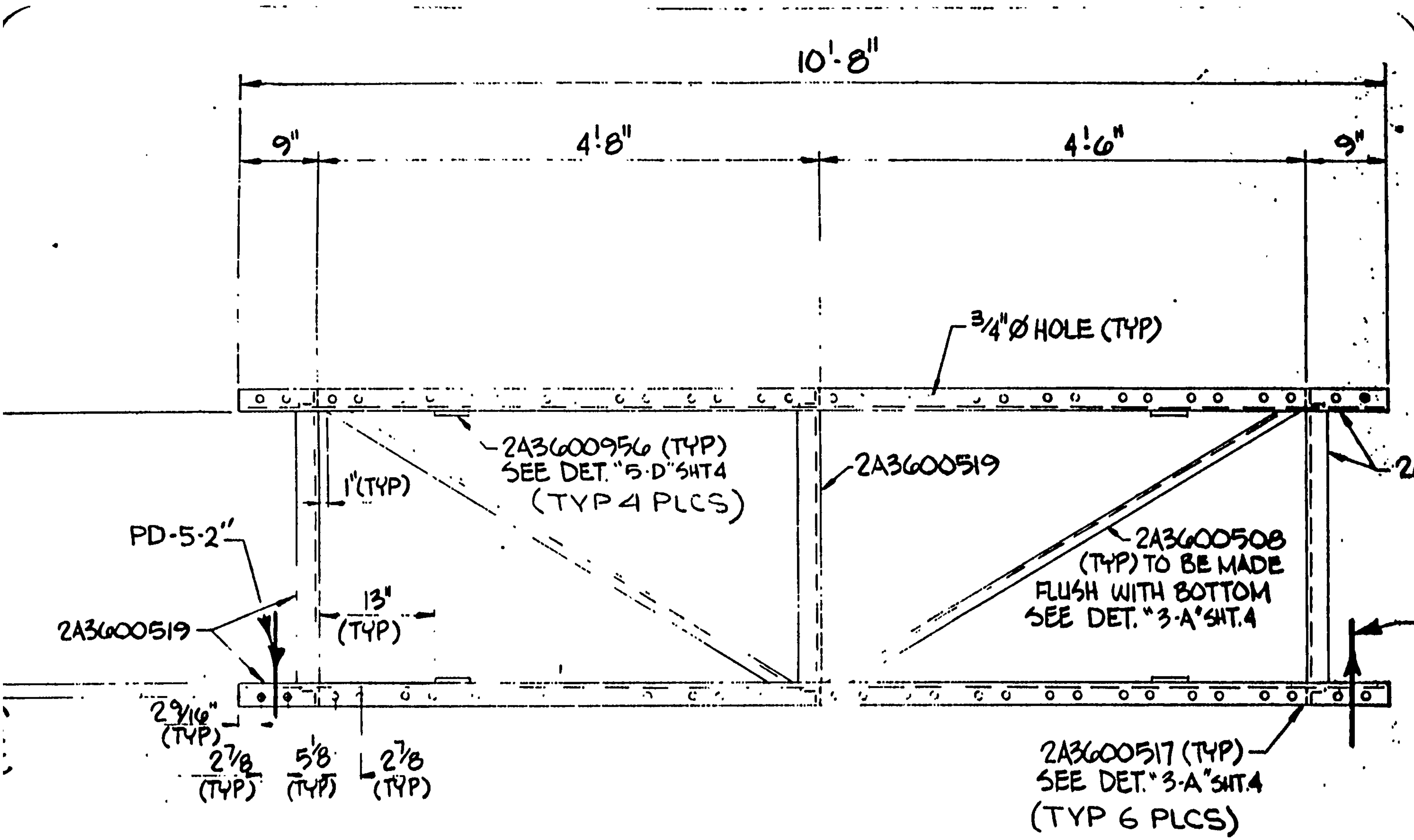
SECTION 18-E"
FR 58-57
LKG. AFT.
SCALE: 1/4" = 1'-0"


SECTION 'B-E'
FR 57-53
LKG. AFT.
UNIT-35
UNIT-34
UNIT-10
UNIT-8
INERT GAS SCRUBBER PUMP PACKAGE UNIT DWG 81-M11-06X REF 50
MN & HARBOR S.W. PUMP PACKAGE DWG 81-010-01V REF 58
E.R. BILGE & BALLAST PUMP PACKAGE DWG 81-M12-04X REF 56
PD16-16"
16" EMER. BILGE SUCT.
PD 72-4"
6" LO DRN TK. SUCT. HDR.
PD91-2"
2" DRN FR. CHARGED AIR RECIEVER
PD56-10"
1/2 FROM OILY WATER SEP. (FAR)
2 1/2 TO OILY WATER SEP. (NR)
PD101-2"
8" TO DESALINAT
PD17-8"
REF 59
5" BILGE SUCT. FROM BILGE WELL CONT ON REF 58
PD69-5"
PD18-8"
8" INERT GAS SCRUBBER PUMP DISCH.
PD93-10-5"
1" TO OILY WATER HOLD. TK. FROM OILY WTR. MONITOR
1/2 FROM ME CONN. #46447
PD60-6" ADJ PC
PD59-6" ADJ. PC
5/8" R
1/2" COND RET.
PD63-6"
6" FROM OILY WATER HOLD
STM RETURN FR OILY WATER HOLD & H.F.O. DRN
HEAT EXCHANGER
VENT
CONT ON REF 50
25
20
15
10
5
5


STM RETURN FROM OILY WATER HOLD TK & H.F.O. DRN TK
ASSY #1
H.F.O & D.O PURIFIER SKID
DWG 8711310
P.O. EX 538
PD121-8"(NR)
#ADJ. PC.
PD122-8"(FAR)
#ADJ. PC.
H.F.O. PUMPING SKID
DWG 8711309
P.O. EX 538
UNIT-34
UNIT-8
BILGE & BALLAST PUMP PACKAGE
DWG 81-M12-04X
REF # SK
PD89-3"
PD146-3"
PD147-3"
PD95-2½"
1'-0" STRG.
PD55-4"
PD88-3"
PURIFIER & PUMPING SKID DRNS TO SLUDGE TK SEE PART PLAN & SECT D-D REF #1 FOR INFO.
PD92-3"
#ADJ. PC
SECT FR
PD91-3"
6"FROM OILY WATER HOLD TK
PD94-2½"
PD87-3"
PD90-3"
PD93-2½"
16'-0" (REF)
SECT FR-53
TANK TOP 7'-3"
PD81-6"
PD96-2½"
PD59-6"
#ADJ. PC
BILGE WELL
PD119-4"
PD85-3"
PD113-6"
PD99-6"
PD74-4"
PD183-2"
PD184-2"
PD165-2½"
PD126-2"(BLW)
PD127-2"(ABV T.T.)
#ADJ. PC.
PD80-6"
180265
80272(FAR)
80269(NR)
PD70 2½"
½" COND RET.
PD114-2"
PD34-2"
PD33-2"
PD32-2"
PD118-6"(NR)
PD119-6"(FAR)
122204
PD31-2"
SLUDGE TK.
7'-3" (REF)
SLIDG
SHIP
120253
CNDS FR M OILY WATER HOLD TK
CNDS FROM HFO ... TK
1"T.L.I (NR) 062206-1"
1½ S.T (FR) 062108-1½"
10
15
20
25
30
35
NOTE: PIPE DETAILS FOLLOWED BY #(ADJ PC), APPLY TO GENERAL NOTE #1

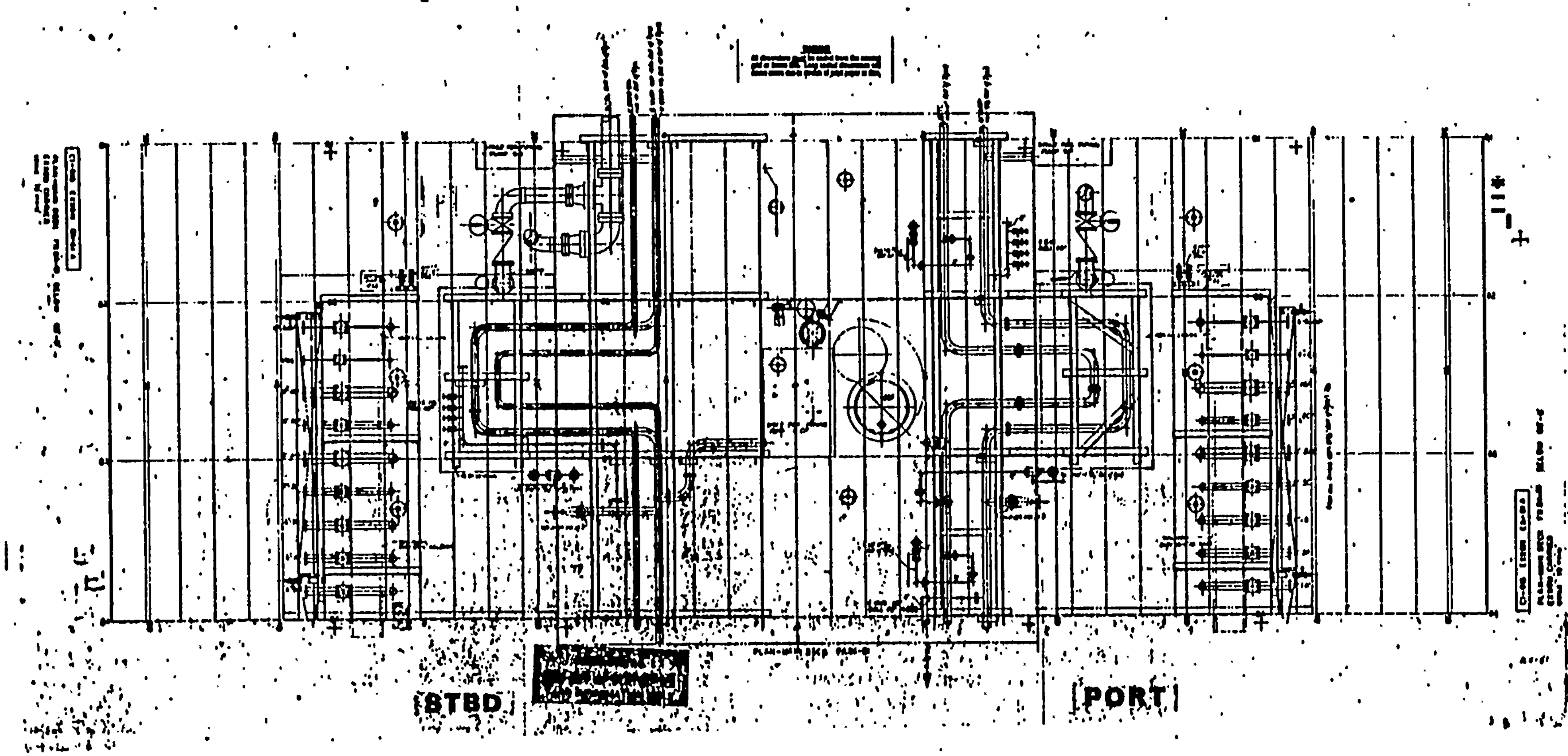


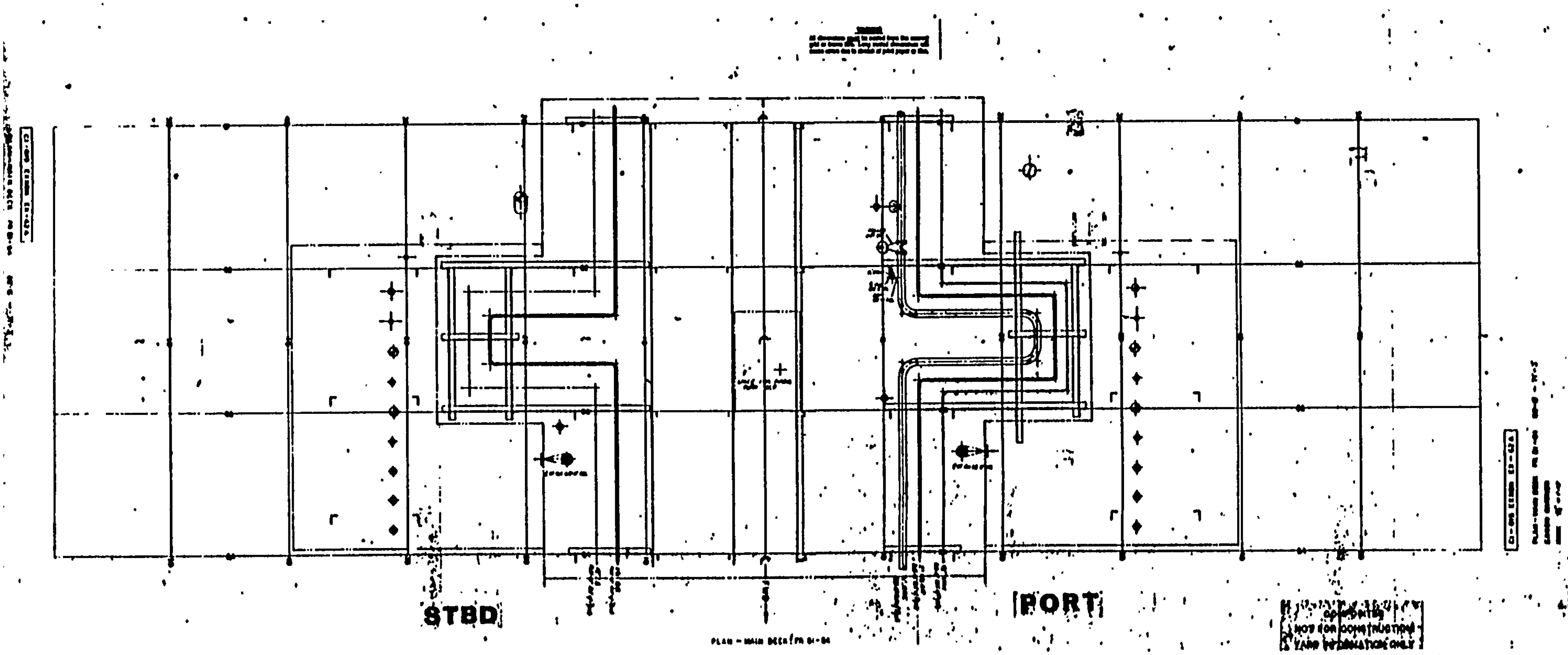
TANK 76
CONT ON REF 2
CONT ON REF 2
FOR STRUCT. DET. SEE PLAN "2-G" SHT. 3
SEE NOTE 10 (TYP)
PD-7-2" (INLET)
PD-8-2" (OUTLET)
PD-3-2"
PD-6-2"
PD-6-2"
PD-6-2"
PD-5-2" (OUTLET)
PD-4-2" (INLET)
PD-3-2"
14 7/16"
18" (TYP)
5 1/2"
5'-6"
2'-6"
3'-6"
2'-0"
8'-0"
5'-0"
10"
8" (TYP)
12"
16"
ASSY No 7
NOTE 5
MASTER BUTT
CONT O REF 2
8" (TYP)
10"
FOR STRUCT. DET. SEE PLAN "4-A" SHT. 3
FOR STR SEE PLA SHT. 3



PLAN "2-G"

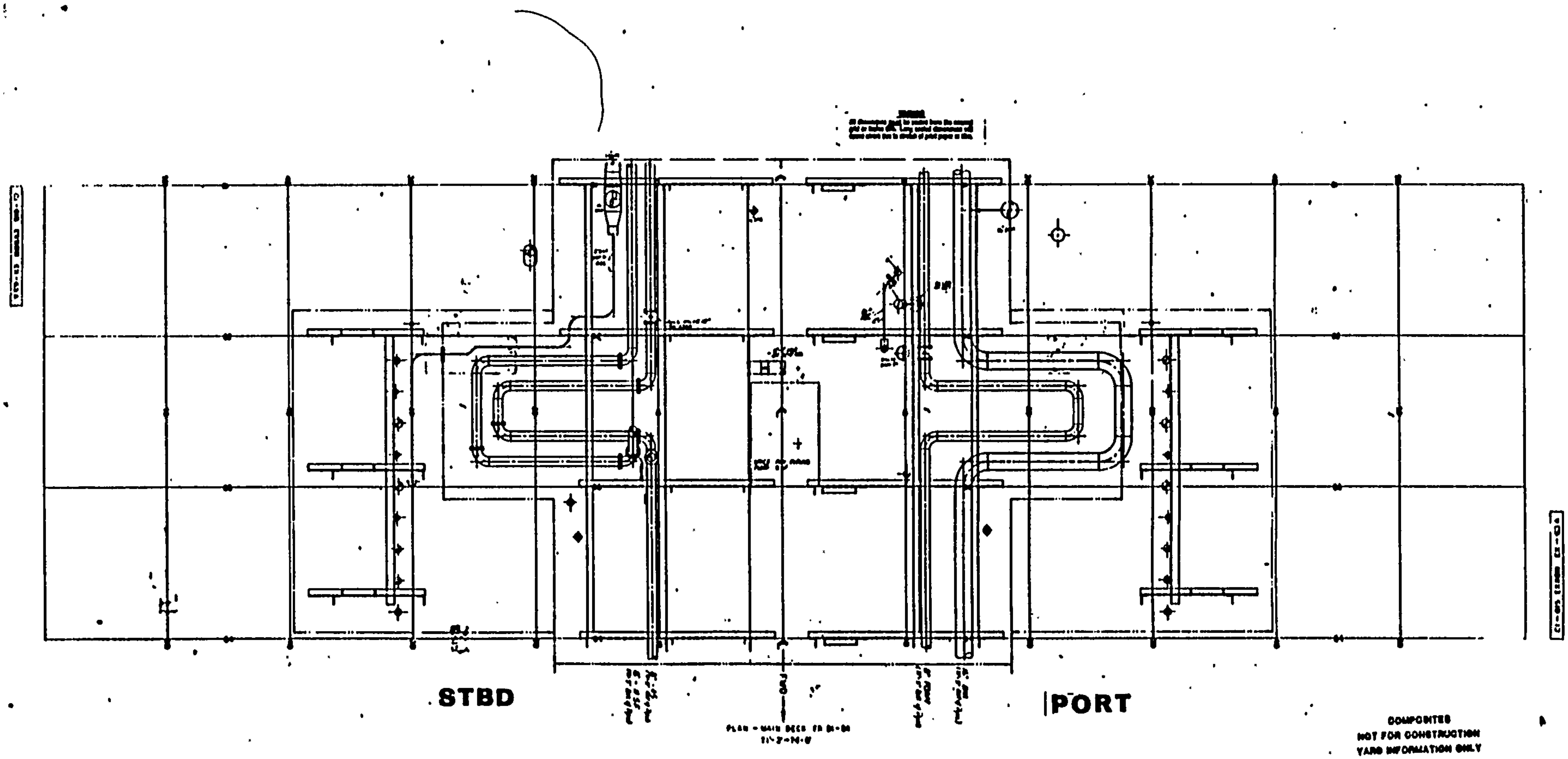
TANK Nº 75, ASSY Nº 7
SCALE 3/4" = 1'-0"


STBD
PORT

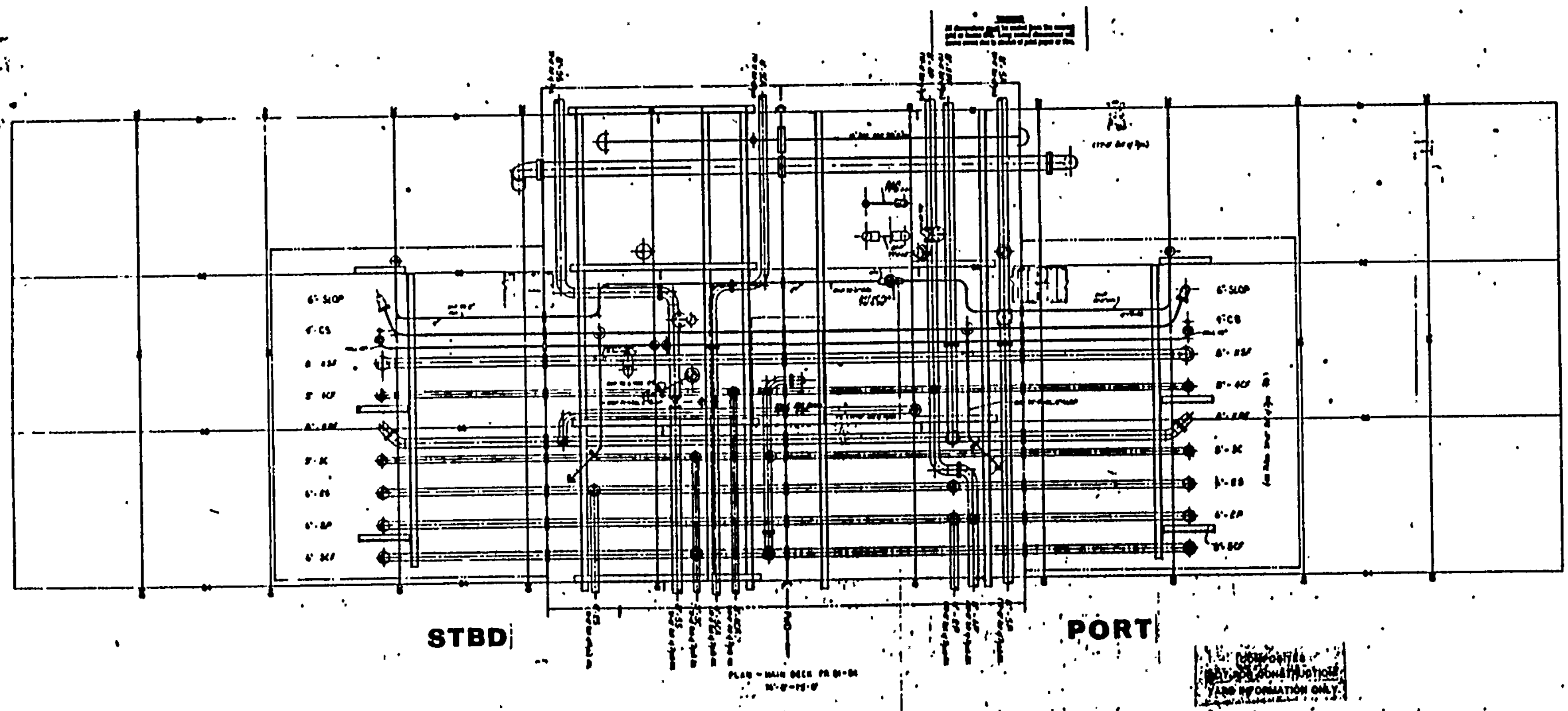


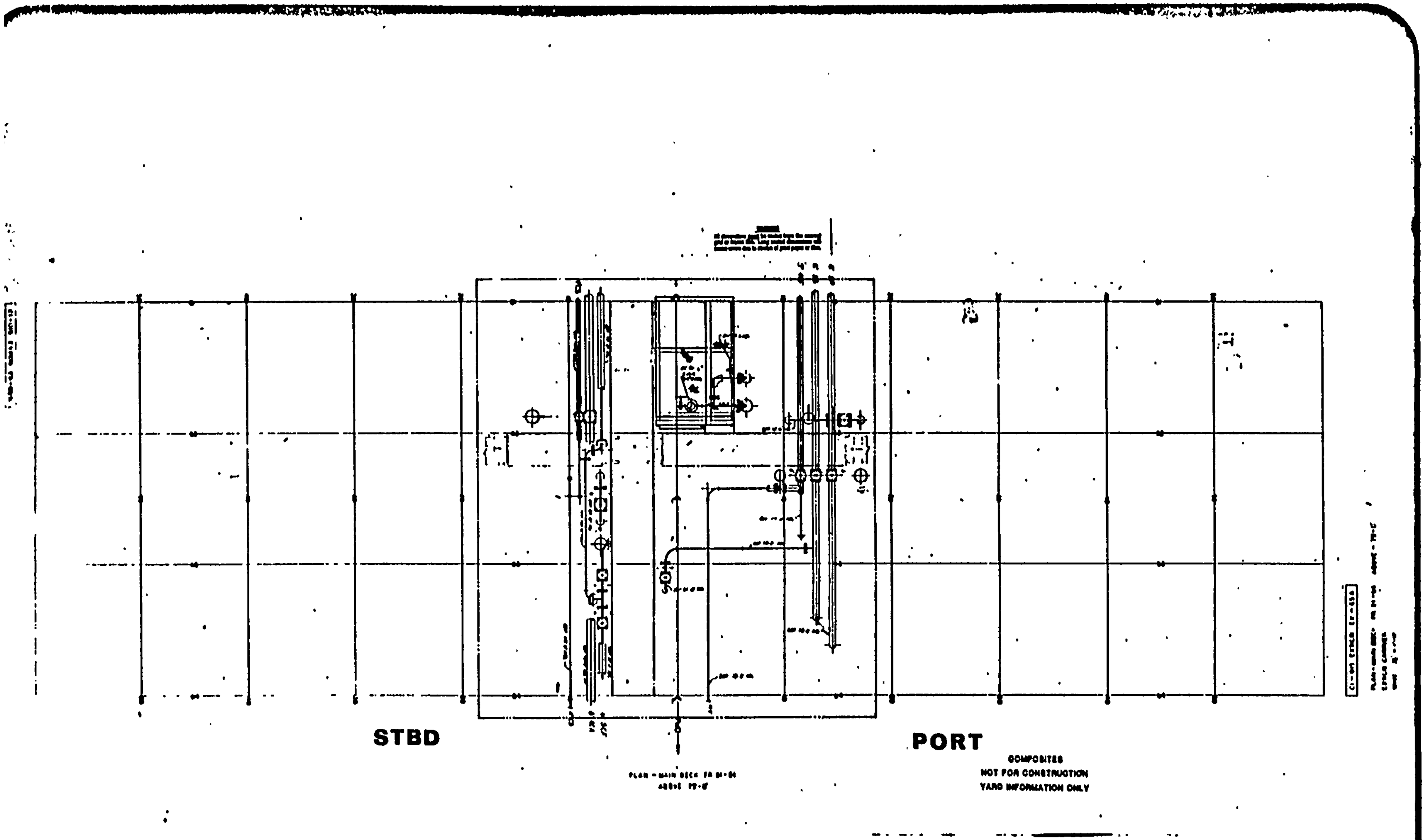
STBD
PORT
PLAN - MAIN DECK FR 81-84
NOT FOR CONSTRUCTION
YARD INFORMATION ONLY

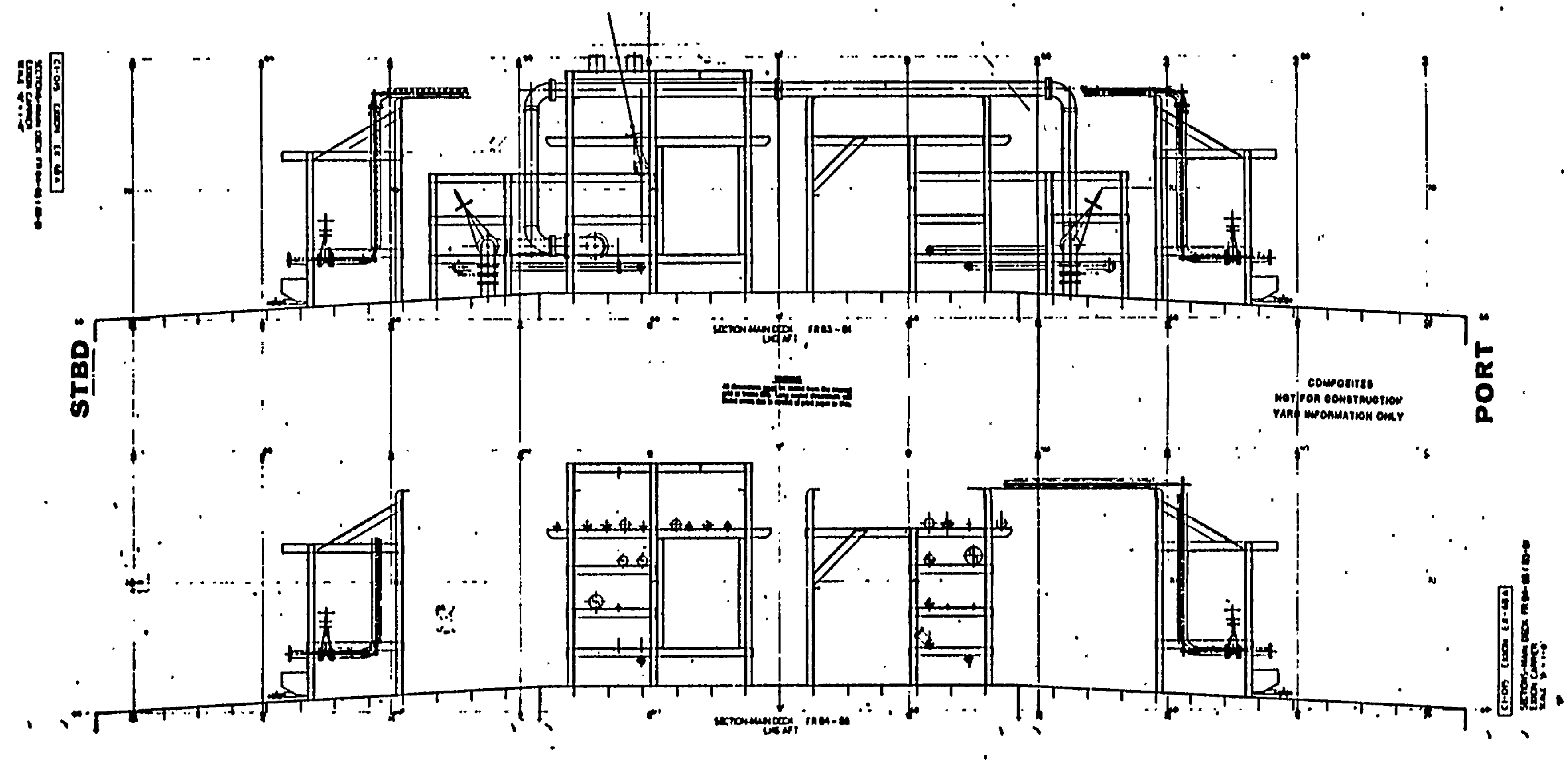
PH-9


STBD
PORT
COMPOSITES
NOT FOR CONSTRUCTION
YARD INFORMATION ONLY

PH-10


STBD
PORT


STBD
PORT
COMPOSITES
NOT FOR CONSTRUCTION
YARD INFORMATION ONLY


STBD
PORT
COMPOSITES
NOT FOR CONSTRUCTION
YARD INFORMATION ONLY

PH-13

GENERAL NOTES

1. ALL PIPING TO BE INSTALLED IN ACCORDANCE WITH THE LATEST RULES AND REGULATIONS OF ABS AND USCG FOR CLASS I & II PIPING.
2. FOR PIPING DESIGN AND TESTING, SEE REF. # 1-7.
3. FOR I/M SEE REF. # 8.
4. FOR P/D SEE REF. # 9.
5. FOR PIPING MATERIAL SCHEDULE, SEE REF. # 18.
6. ALL PIPING TO BE PROPERLY SUPPORTED TO ALLOW FOR EXPANSION AND PREVENT VIBRATION IN ACCORDANCE WITH REF. # 14&15
7. ALL PIPING AND PIPING APPURTENANCES SHALL BE THOROUGHLY CLEANED AFTER FABRICATION AND PRIOR TO INSTALLATION ON SHIPBOARD.
8. TAB DIMENSION THUS ([illegible]) INDICATE DISTANCE OFF CENTERLINE OR ABOVE BASELINE OF SHIP UNLESS NOTED OTHERWISE.
9. STEEL PIPING 2" IPS THROUGH 4" IPS MAY BE BENT TO A RADIUS OF NOT LESS THAN 3 TIMES THE NOMINAL IPS DIA., STEEL PIPING 5" IPS THROUGH 8" STD. IPS MAY BE BENT TO A RADIUS OF NOT LESS THAN 2½ TIMES THE NOMINAL IPS DIA., STEEL PIPES BELOW 2" IPS AND ABOVE 8" IPS SHALL BE BENT TO A RADIUS OF NOT LESS THAN 3 TIMES THE NOMINAL IPS DIA.
10. PIPE SHOWN SCHEMATICALLY TO BE FIELD ROUTED TO SUIT SHIPBOARD CONDITIONS.
11. PIPING TO BE INSULATED AND LAGGED IN ACCORDANCE WITH REF # 17.
12. PIPING ON RACKS TO BE SUPPORTED BY THE FOLLOWING METHODS UNLESS AS NOTED. STEAM PIPING (GEN NOTE # 13) ALL OTHER PIPING TO BE SUPPORTED WITH ASI STD U BOLTS DET [illegible] OR UBA, TYPE "B", 6" & ABV [illegible] UBA, TYPE "B" BLW 6" [illegible] BALLAST PIPING U BOLTS TO BE LINED WITH RUBBER HOSE PC [illegible] # [illegible] (rev. 1)
13. STEAM PIPING TO BE SUPPORTED PER REF # 20 (rev. 1)
14. ALL PIPING TO BE ISOLATED FROM PIPE RACK WITH ⅛" TEFLON PAD.
15. ALL SLOP HANGERS SHALL BE LINED WITH ⅛" TEFLON LINER EXCEPT FOR SLOP ANCHORS (rev. 1)

REFERENCES

REV	NO	TITLE	DRAWING NO
1	23	SLIDING PAD	SK 048
1	22	MN DK CARGO PUMPS HANG ASSY HULL "B"	06 000 66U
1	21	MISC INSTRUMENTATION SKETCHES	87 00 04
1	20	PIPE HANGERS FOR STEAM SYSTEM ON MN DK RACKS HULL "B" ONLY	SK-050
1	19	[illegible]	36-000-778
	18	PIPING MATERIAL SCHEDULE	06-03-10
	17	INSULATING & LAGGING MAT'L SCHEDULE	39-02-01
	16	PAINTING SCHEDULE	17-01-0
	15	CARGO PIPING NON STD SUPPORTS	48-17-216B
	14	STD PIPE HANGER DETAILS	06-00-01
	13		
	12	MN DK RACK PIPING PORT SIDE FR 70-73 PACKAGE UNIT HULL B	91-628-01Y
	11	MN DK RACK PIPING INNER STBD SIDE FR 73-77 PACKAGE UNIT HULL B	91-618-05Y
	10	MN DK RACK PIPING STBD SIDE FR 71-73 PACKAGE UNIT HULL B	91-638-03Y
	9	MN DK RACK PIPING STBD SIDE FR 73-75 PACKAGE UNIT HULL B P/D	91-612-017
	8	MN DK RACK PIPING STBD SIDE FR 73-75 PACKAGE UNIT HULL B I/M	91-618-016
	7	DIAGRAM D O FILL, AFT SIDE & FWD SIDE SYS	53-01-30
	6	DIAGRAM HEAVY FUEL OIL FILL & TRANSFER SYS	56-01-10
	5	DIAGRAM SHIPS SIDE START LOAD AIR SYS	47-01-10
	4	DIAGRAM MN DK STM & CNDS RETURN	46-10-20
	3		
	2	DIAG SEGREGATED BALLAST AND VT & SOUND SYS	46-01-20
	1	DIAGRAM LIQUID CARGO SYS (SHIP B)	48-17-10B

REVISIONS

REV		DESCRIPTION
0	ALL	
1		1 REVISED 4" [illegible] TO CROSSOVER PER DIAG. CHANGE
		2 SHIFTED ALL ANGLES 6B' AND BELOW. (SHT #2)
		3 REVISED STANCHION OUTBOARD FR 73 (SHT. #2)
		4 RELEASED RESERVATIONS #2, 3, 4 REVISED GENERAL NOTE # 12 & 13 ADDED GEN NOTE 14 & 15 ADDED REF # 19 20, 21, 22 (2)
		5 ADDED WIREWAY SUPPORT STRUCTURE (SHT #2)
		6 ADDED P/V BREAKER PLATFORM. (SHT. #2)
		7 ADDED LIFTING PADS [illegible] ABL. ALL FRS (SHT. #2)
		8 REVISED STRUCTURE AT ENDS OF TRUNK & ADDED 80-669-16A TO SHT WIREWAY CABLE. (SHT. #2)
		9 ADDED "X" & "Z" TYPE SUPPORTS DETAILS AND LOCATED "X", "Y" & "Z" HANGERS THROUGHOUT DWG AS REQUIRED
		10 REROUTED PORTION OF 4" FIRE PIPING TO MAKE ROOM FOR P.V. BREAKER.
		11. ADDED DETAIL B-A (SHT 3)
		12 ADDED [illegible] BRACING [illegible] LEVEL.

RESERVATIONS

NO	DESCRIPTION
4	~~RESERVE LUA CROSSOVER PIPE PENDING DIAGRAM REVISION~~
3	~~RESERVE LET LOCATION FOR STEAM PIPING SUPPORTS (SEE NOTE # 13)~~
2	~~RESERVE REFERENCES FOR [illegible] TANKS & CONN FOR RACK PIPING AFT OF FR 73~~
1	~~RESERVE INERT GAS LINE PENDING SIZE.~~

THIS DRAWING FOR
ASI HULL 2335
SHIP B ONLY

AVONDALE SHIPYARDS INC
P O BOX 50280
NEW ORLEANS, LA
70150

DRAWN BY: M. VARDE
CHECKED BY: J. KIRKS

ASI JOB NO: **C1-15** JUN 25 1982

EXXON COMPANY, USA

42,000 DWT MULTI-PRODUCTS CARRIERS
MN DK RACK PIPING
STBD SIDE FR 70-73
PACKAGE UNIT HULL B

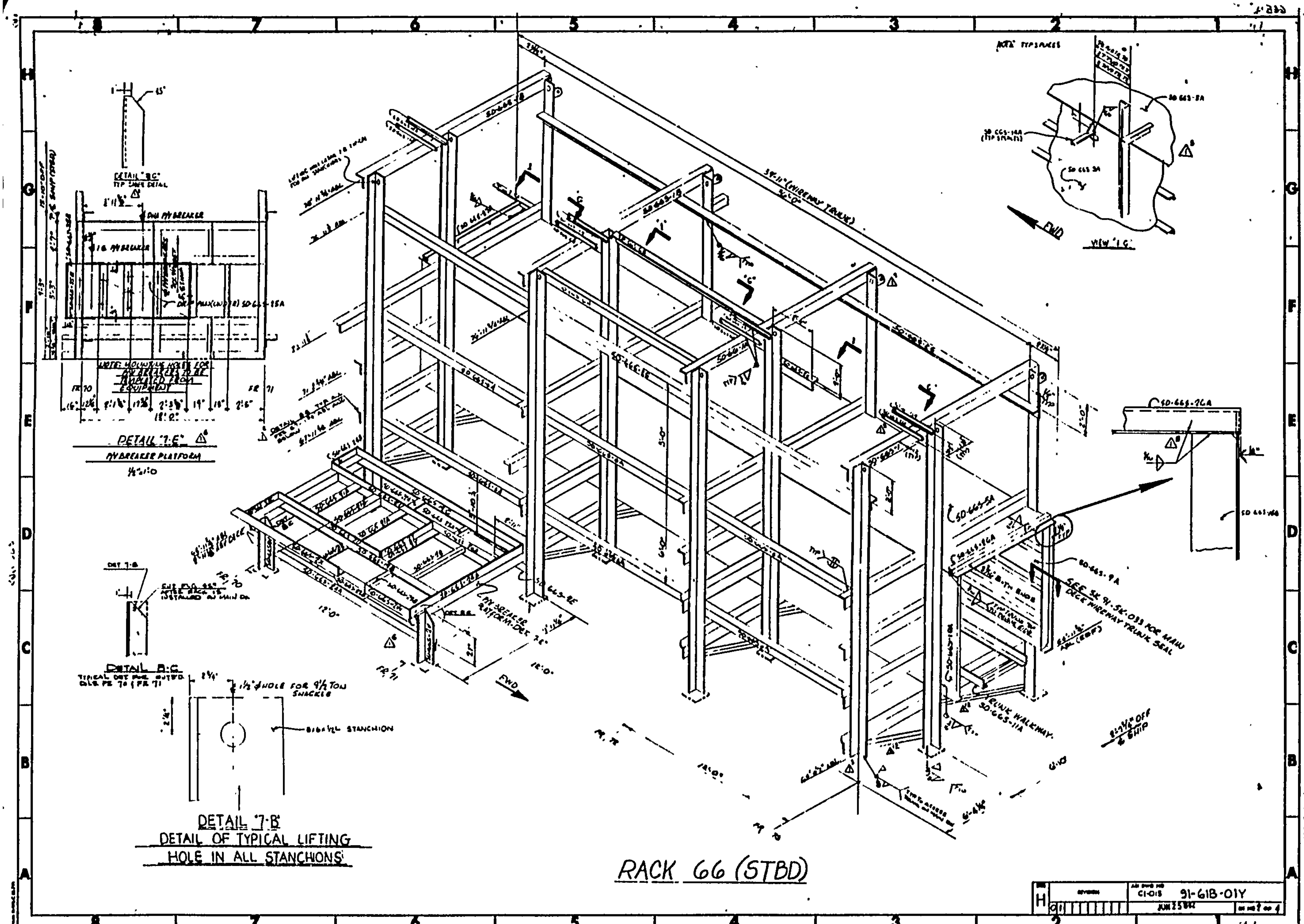
SIZE: H | ASI DRAWING NO: C1-15 91-61B-01Y | REV: 1

SCALE: ½" = 1'-0" | SH 1 OF 4

C1-15 91-61B-01Y

DISTRIBUTION

C1-15 91-61B-01Y



DETAIL "7-E"
DETAIL "B-C"
DETAIL "7-B"
DETAIL OF TYPICAL LIFTING
HOLE IN ALL STANCHIONS
SNACKLE
STANCHION
VIEW '1-G'
FWD
RACK 66 (STBD)
91-61B-01Y

PH-16

ASI DWG NO C1-15 91-61B-015 REV 1

REV	NO	TITLE	DRAWING NO
	4	STANDARD PIPE HANGER DETAILS	06-00-01
	3	MAIN DECK RACK PIPING STBD SIDE FR 70-73 PKG UNIT HULL B L/M	91-61B-016
	2	PAINT SCHED. ZONES A,D,M.	19-01-01
	1	MN. DK. RACK PIPING STBD SIDE FR. 70-73 PKG. HULL "B" ONLY	91-61B-01Y

REFERENCES

RECORD INFO

THIS DRAWING FOR JUN 25 1982
~~ASI HULL 2335~~
~~SHIP B ONLY~~

ASI HULL NO	NAME OF VESSEL
~~2007~~	
~~2006~~	
2335	

AVONDALE SHIPYARDS INC
P O BOX 50280
NEW ORLEANS, LA
70150

A S I JOB NO **C1-15**

EXXON COMPANY, USA

42,000 DWT MULTI-PRODUCTS CARRIERS
MN DK RACK PIPING
STBD SIDE FR 70-73
PKG UNIT HULL
STRUCTURAL DETS

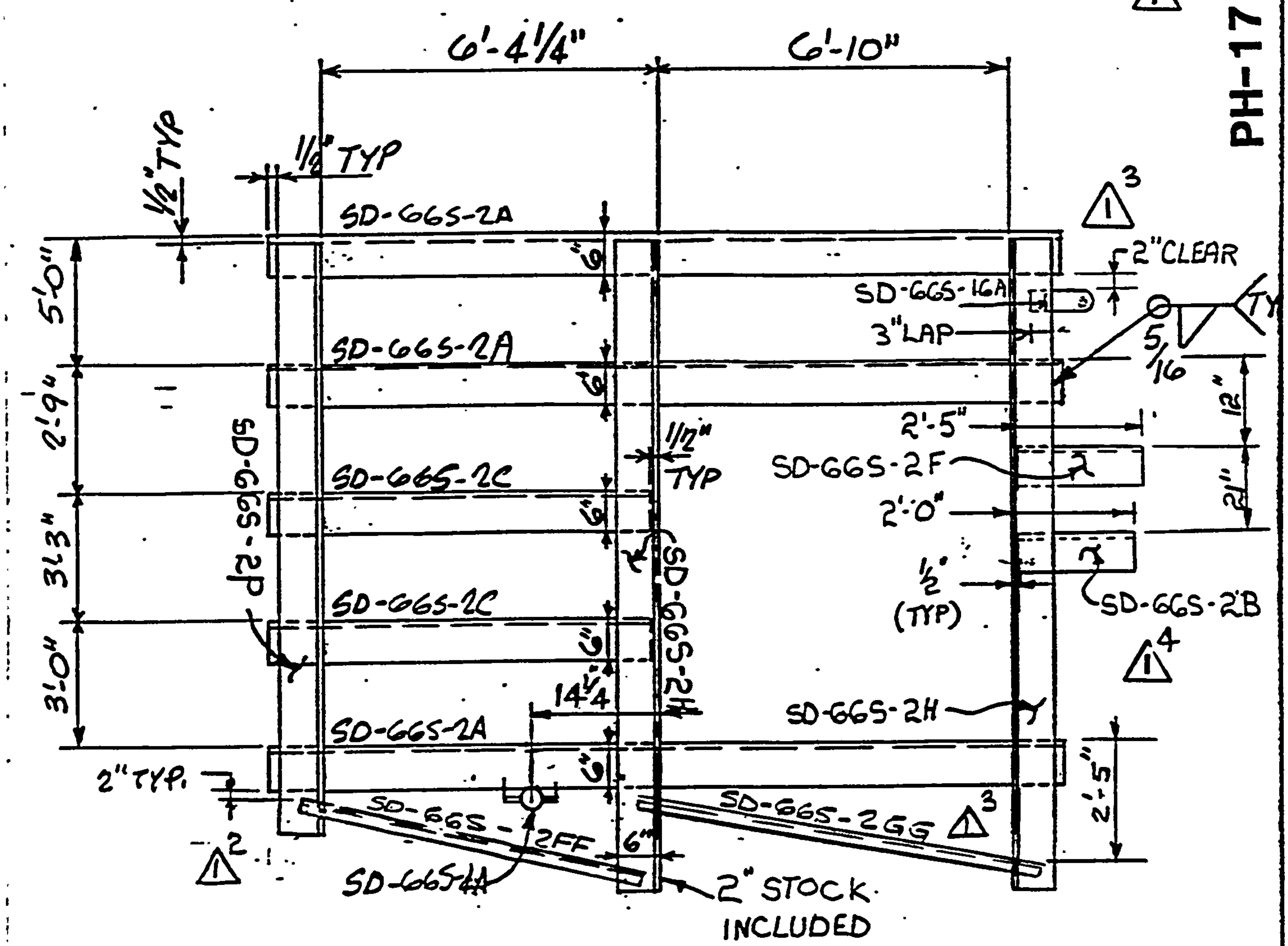
DRAWN BY KAS DATE 10/22/81
CHECKED BY Jac. DATE 12/1/81
APVD [signature] MECH. ENGINEER
APVD A Nierenberg 12/7/81 ASST CHIEF ENGINEER
APVD 12/9/81 R.B. Ekholm PROGRAM MANAGER

SIZE	ASI DWG NO	REV
A	C1-15 91-61B-015	1

SCALE SH 1 OF 37

S.D. NO. 66S-1
NO. REQD. ONE
FR 73
PALLET-CODE
0020-61B-01R

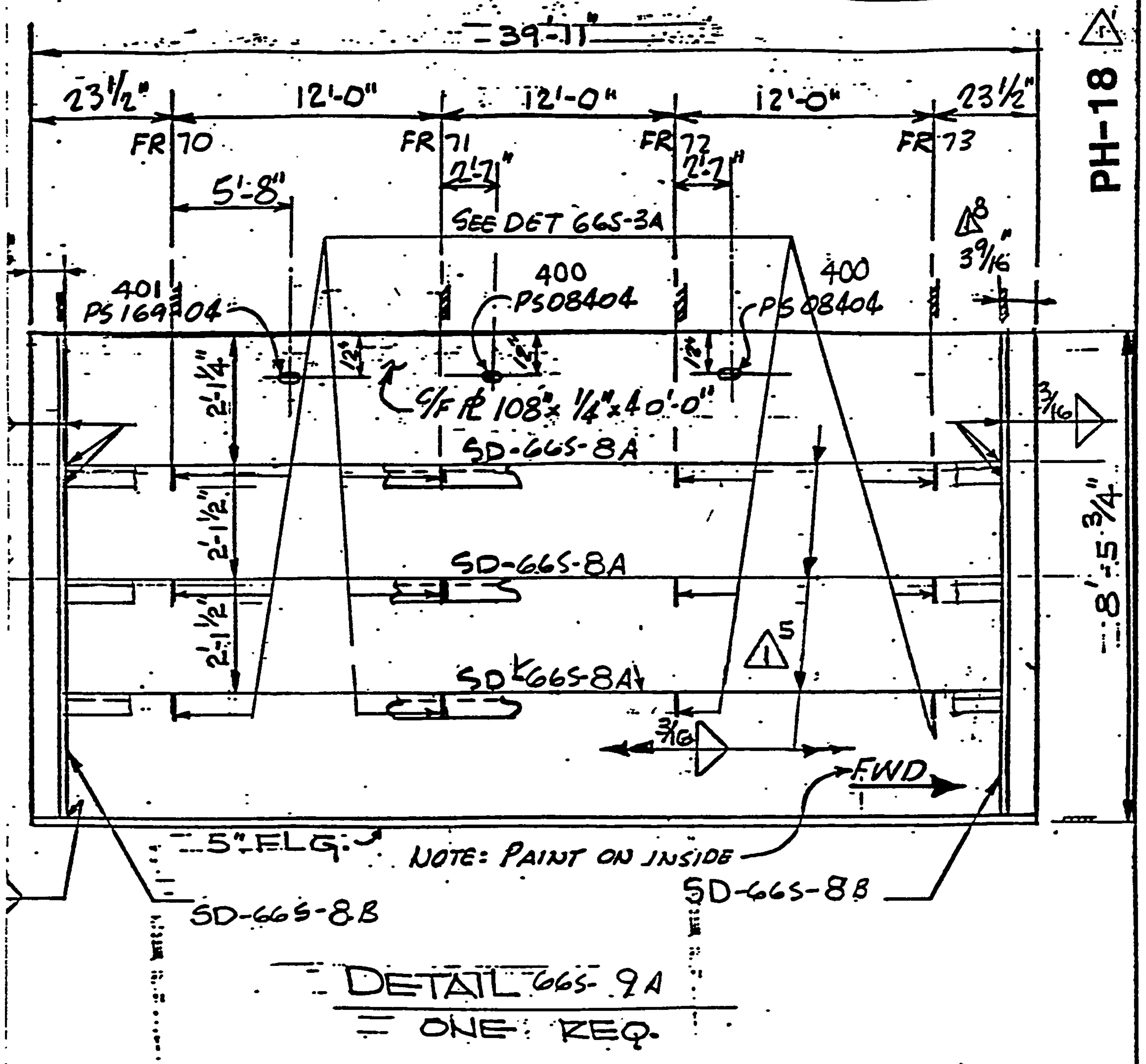
PH-17



AVONDALE SHIPYARDS, INC. P.O. BOX 50280 NEW ORLEANS, LA. 70150	JOB NO. C1-015 DWG. NO. 91-618-015
TITLE: STRUCTURAL DETAIL SH5	DWN F REVISION 1

S.D. NO. 665-9
NO. REQD. NOTED

PALLET CODE
0020-618-01



MK

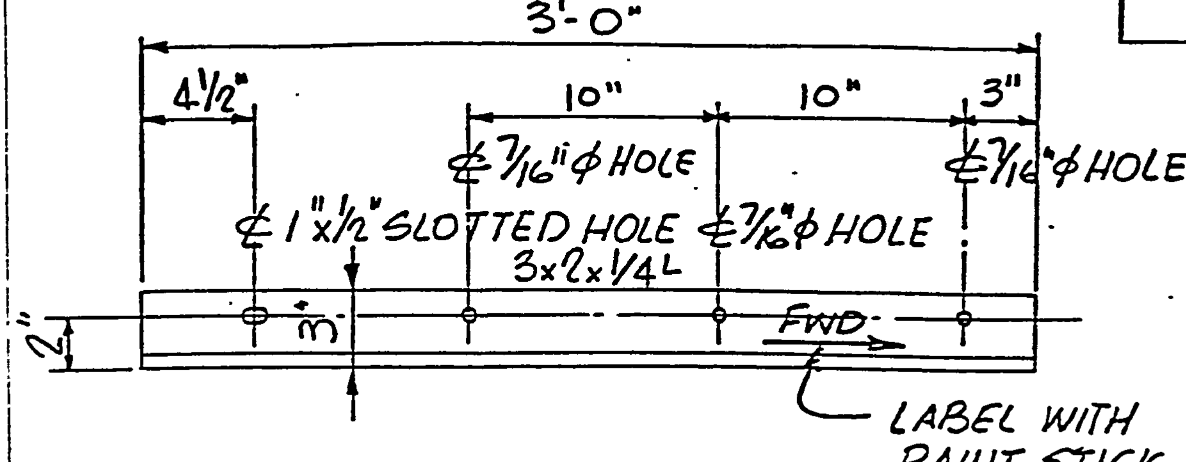
13227/3 - PLATE - 108" x 1/4" x 40'-0" (AH-32)

AVONDALE SHIPYARDS, INC. P.O. BOX 50280 NEW ORLEANS, LA. 70150	JOB NO. C1-015
TITLE: STRUCTURAL DETAIL	DWG. NO. 91-618-015
	DWN KAS
	REVISION

S.D. NO. 66S-15
NO. REQD. NOTED

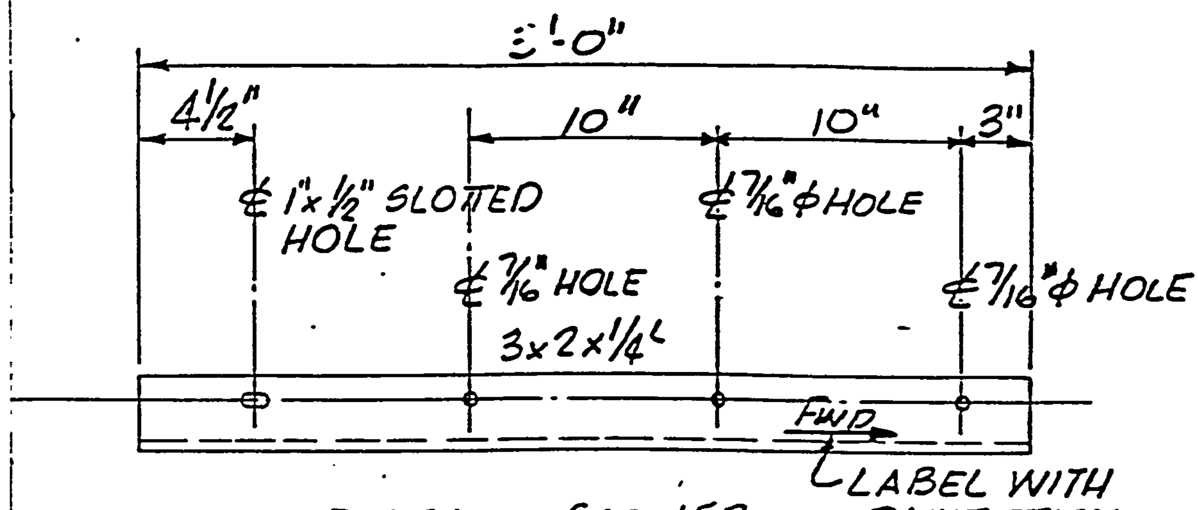
PALLET CODE
0020-901-01

PH-19



DETAIL 66S-15A

4-REQD



DETAIL 66S-15B

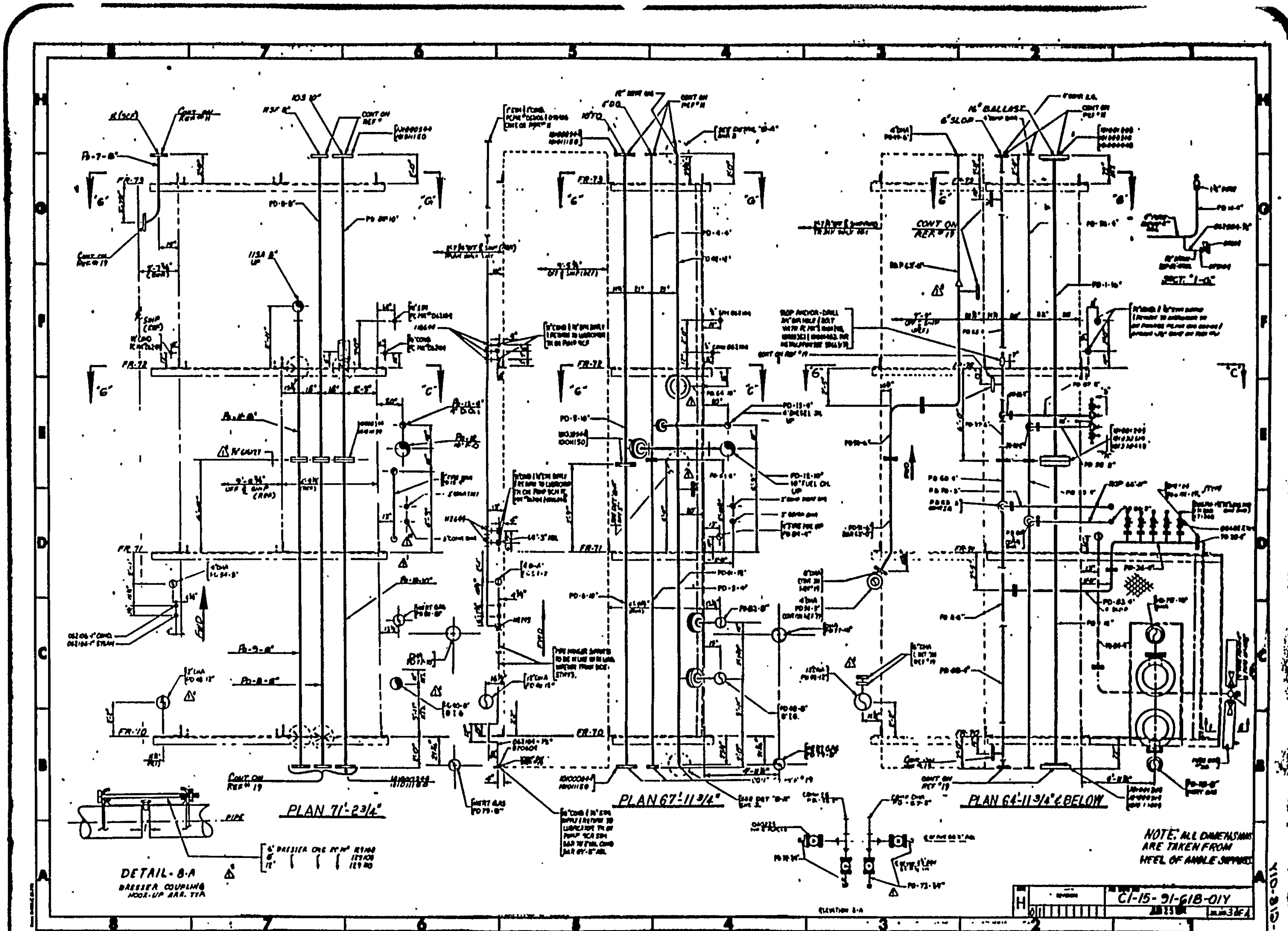
4-REQD

?C MK

?A3600618 - ANGLE - 3x2x1/4 (ASTM-A36)

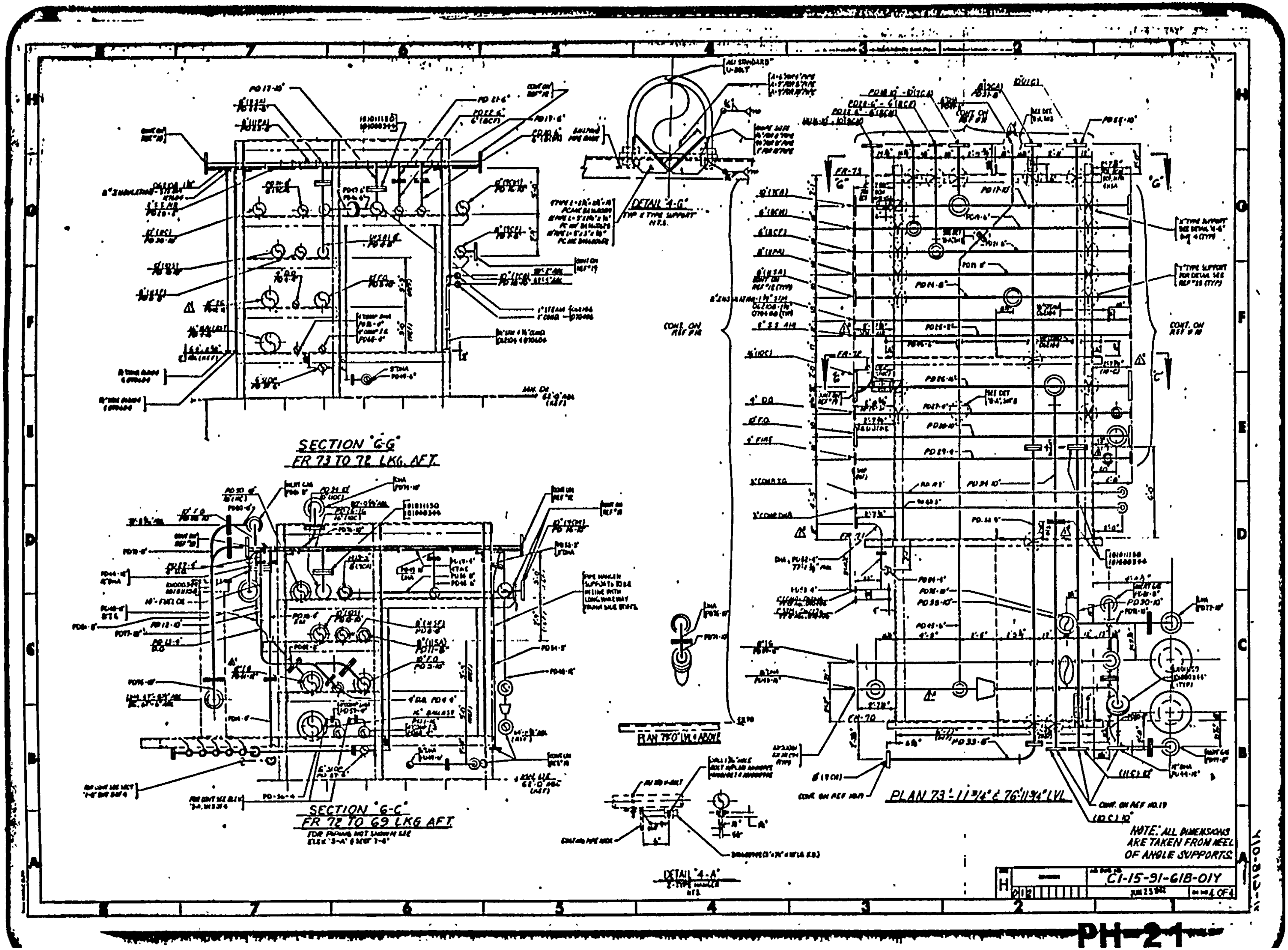
△1 6

IST DE	AVONDALE SHIPYARDS, INC. P.O. BOX 50280 NEW ORLEANS, LA. 70150	JOB NO. C1-015
	TITLE: STRUCTURAL DETAIL	DWG. NO. 91-61B-0
		DWN. T
		REVISION

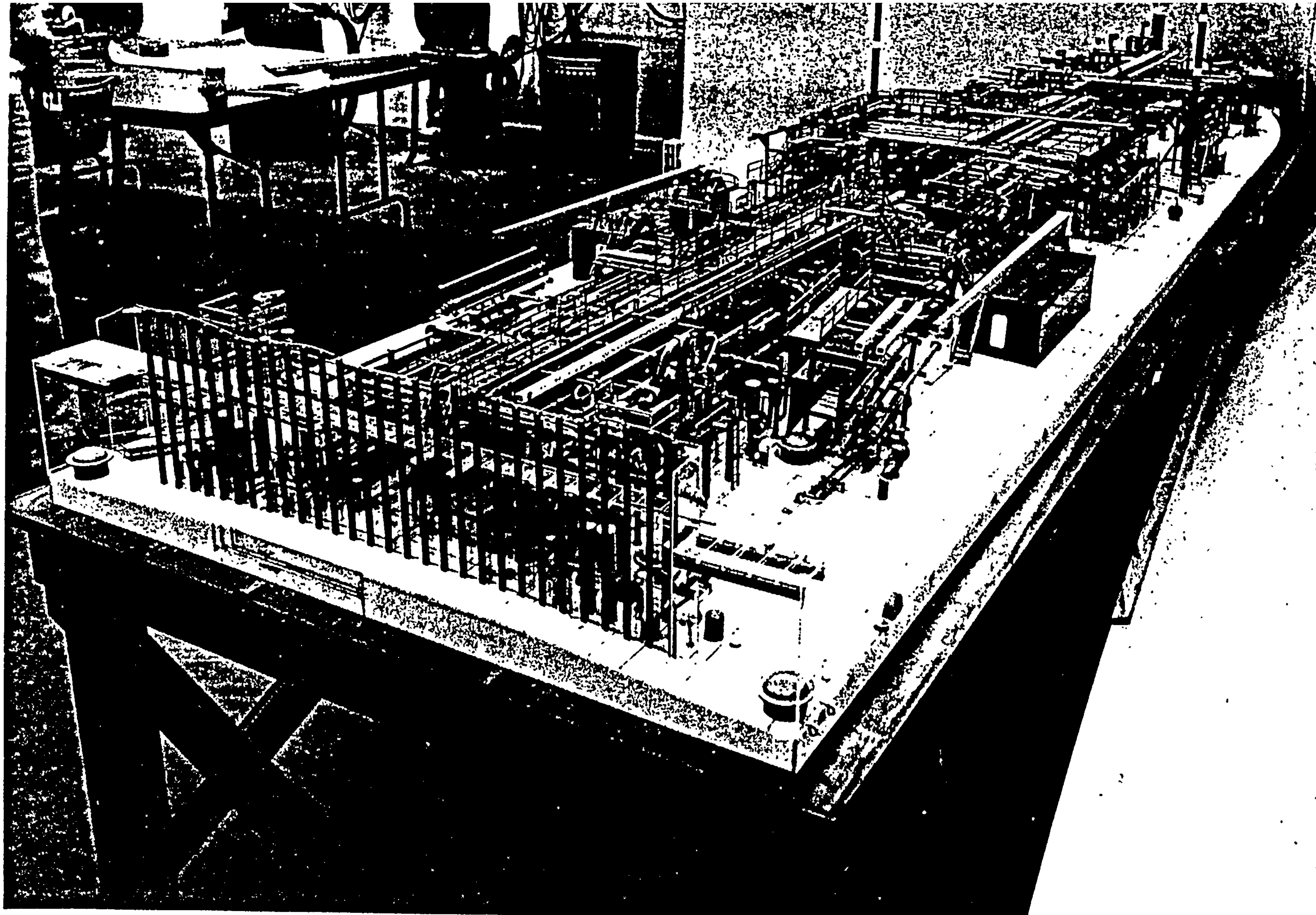


PLAN 71'-2 3/4"
PLAN 67'-11 3/4"
PLAN 64'-11 3/4" & BELOW
DETAIL-8-A
DRESSER COUPLING
HOOK-UP ARR. TYP
NOTE: ALL DIMENSIONS ARE TAKEN FROM HEEL OF ANGLE SUPPORT
FR-73
FR-72
FR-71
FR-70
CONT ON REF 19
6" BALLAST
6" SLOP
10" FUEL OIL UP
PIPE
SECT. "1-13"
ELEVATION 8-A
C1-15-91-G1B-01Y

PH-20



SECTION "G-G"
FR 73 TO 72 LKG. AFT.
SECTION "G-C"
FR 72 TO 69 LKG AFT
DETAIL "4-G"
TYP. E TYPE SUPPORT
N.T.S.
PLAN 79'-0" LVL & ABOVE
DETAIL "4-A"
PLAN 73'-11 3/4" & 76'-11 3/4" LVL
CONT. ON REF NO. 19
NOTE: ALL DIMENSIONS ARE TAKEN FROM HEEL OF ANGLE SUPPORTS.
C1-15-91-618-01Y
4 OF 4
PH-21



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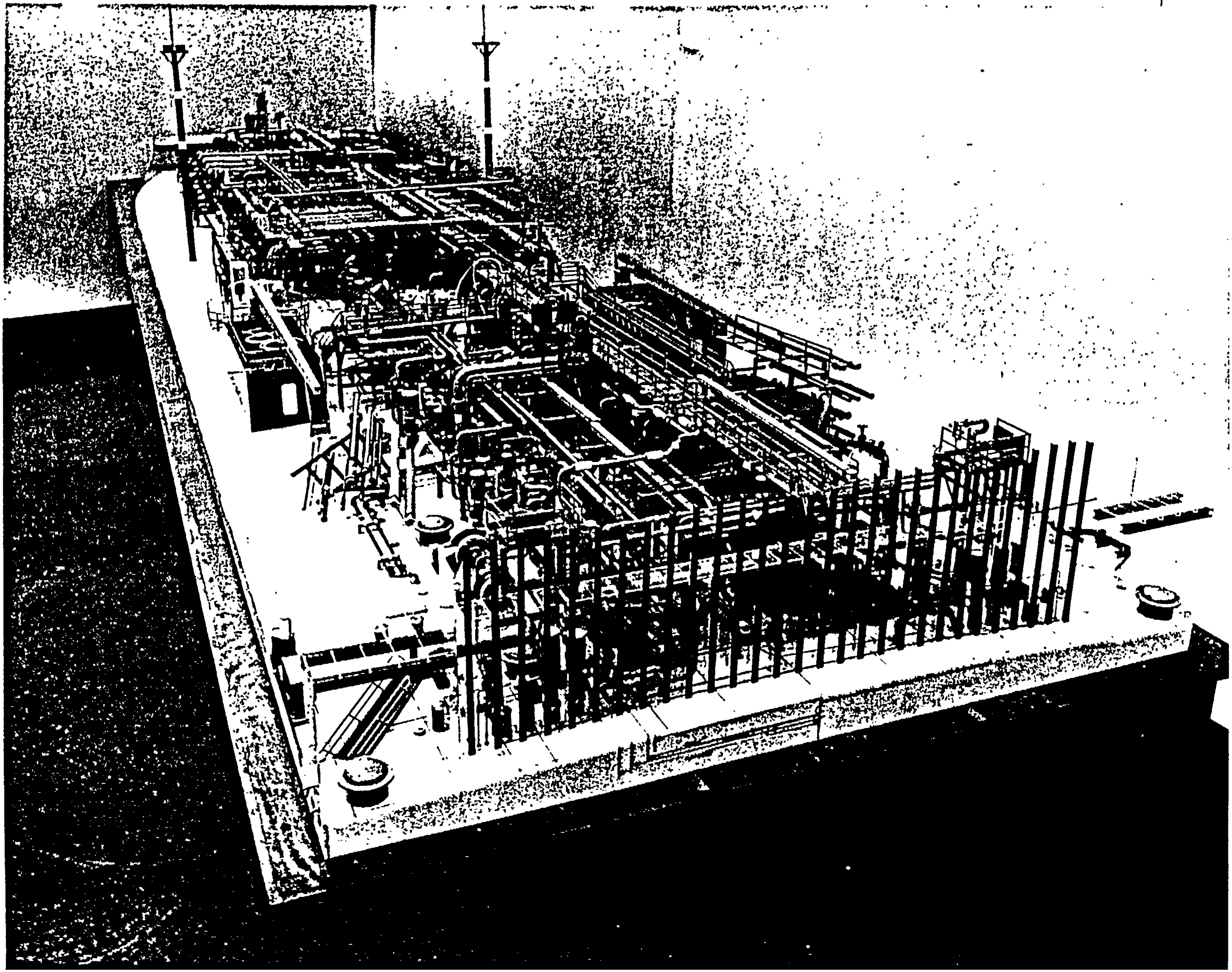

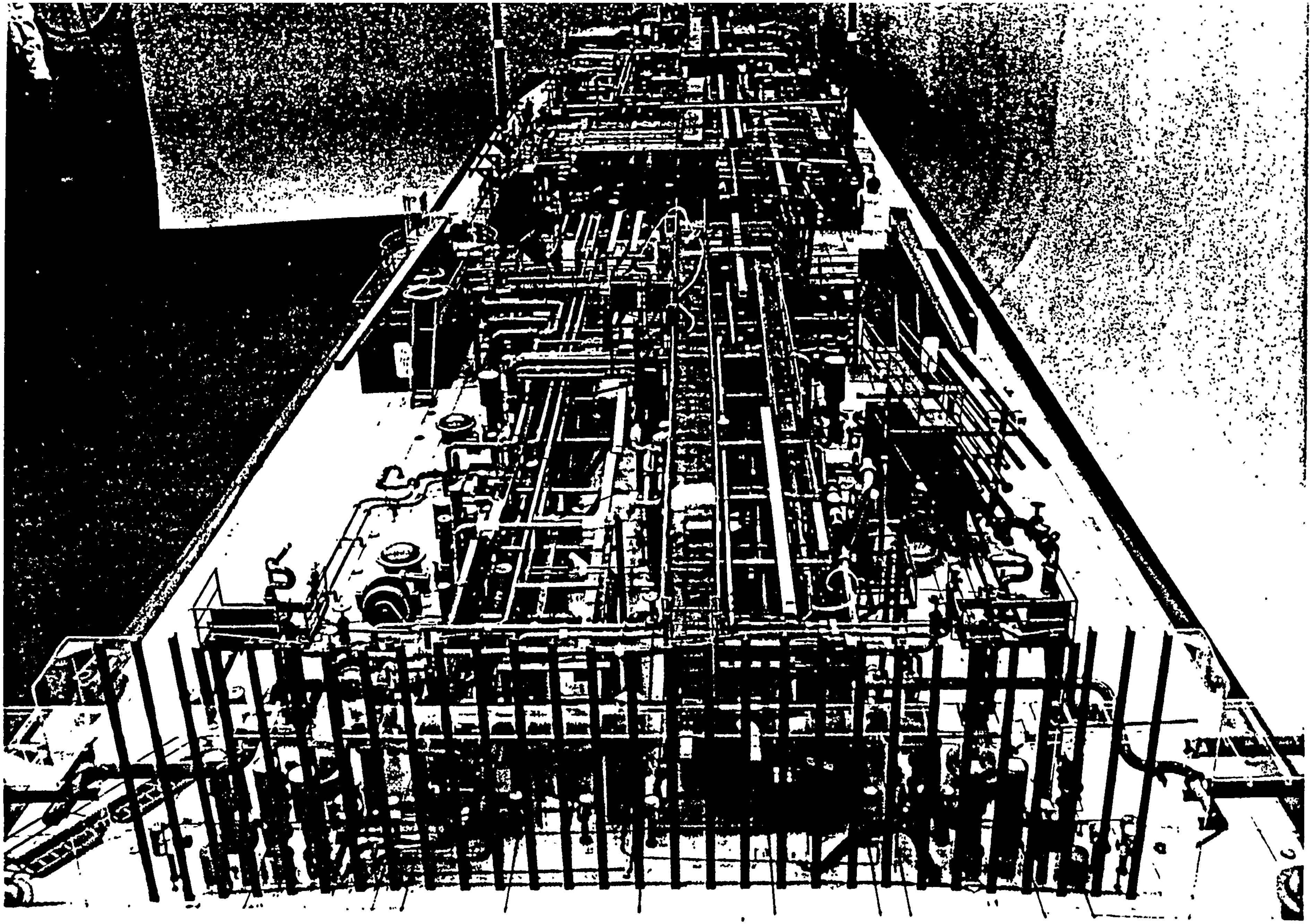

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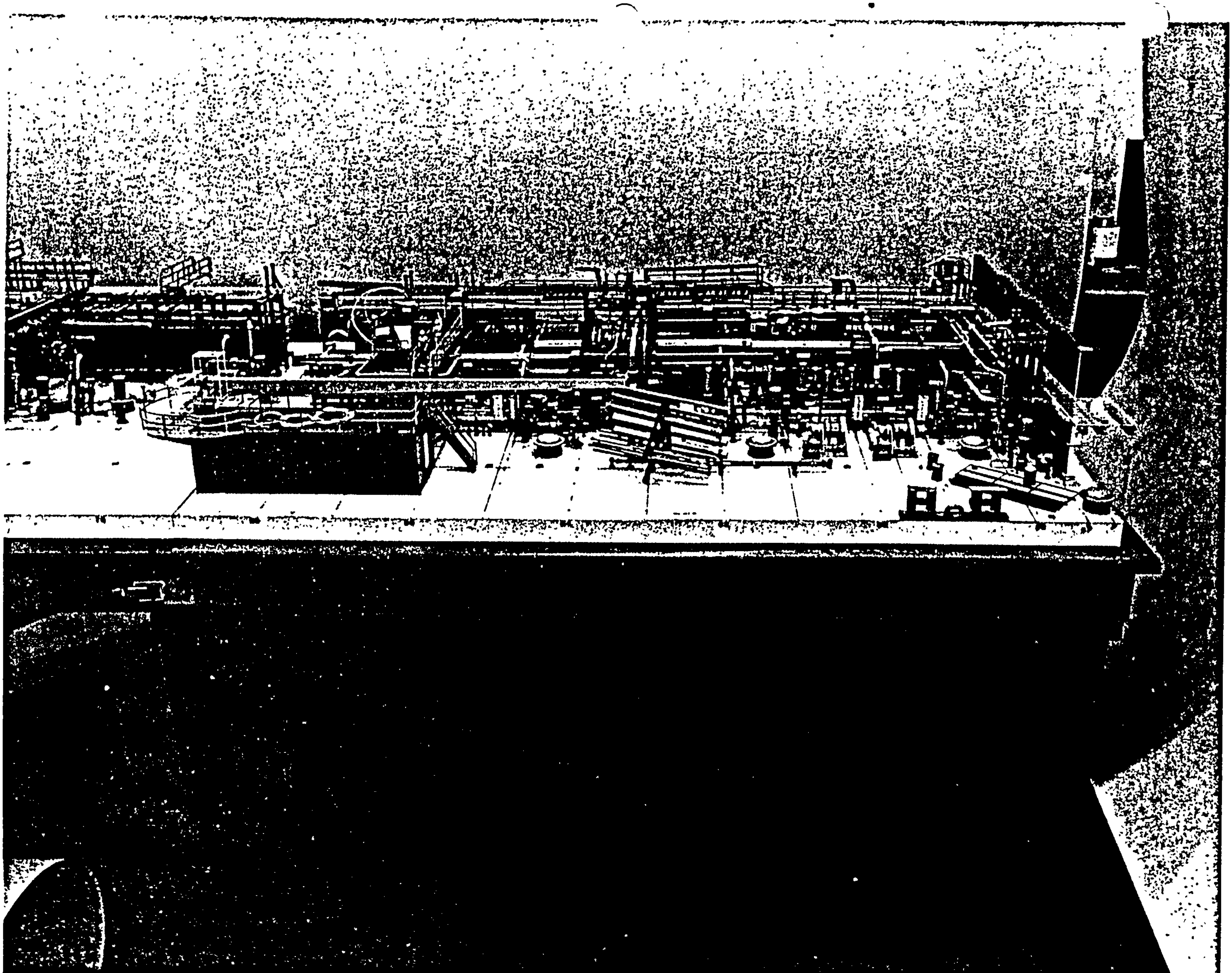
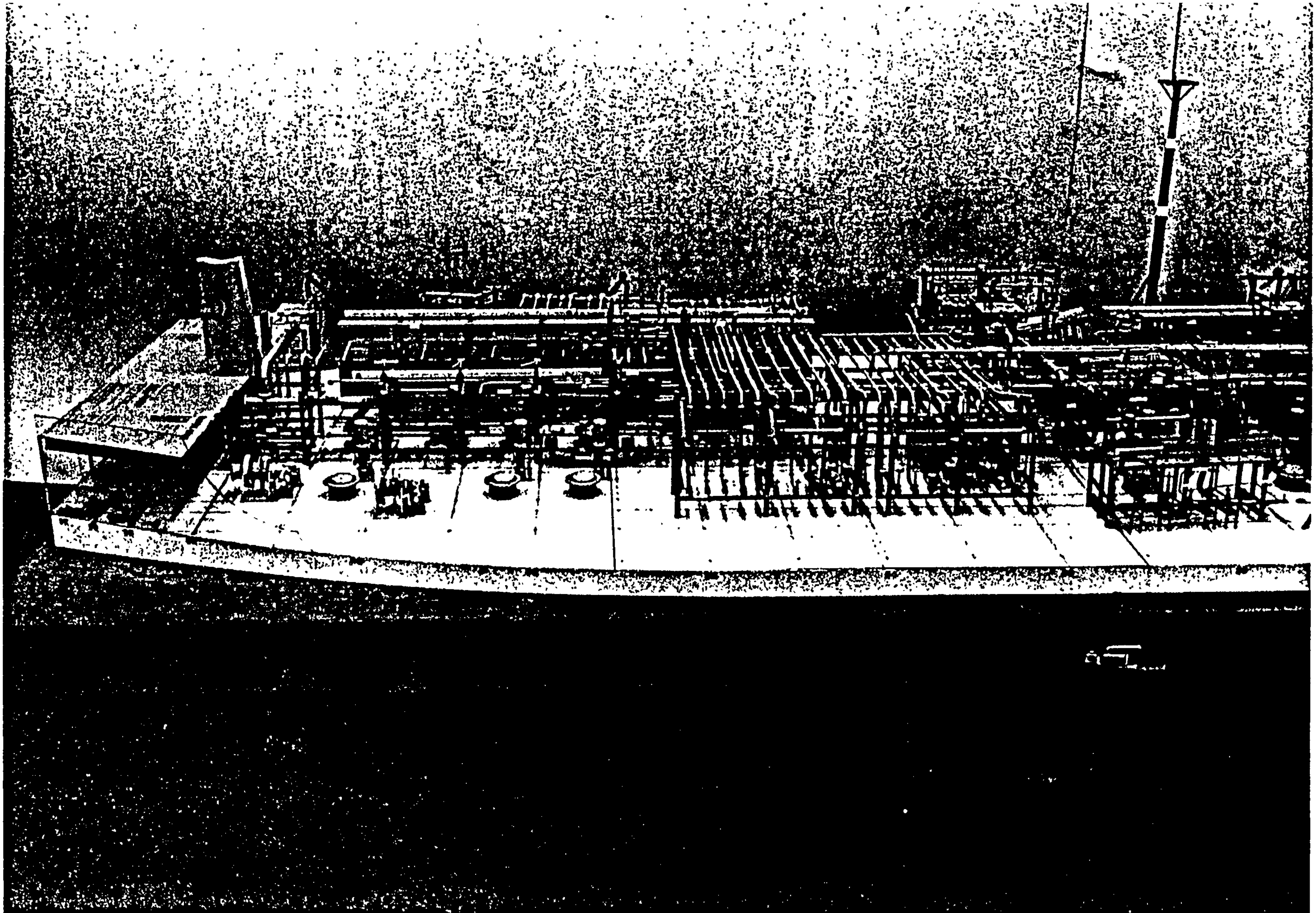
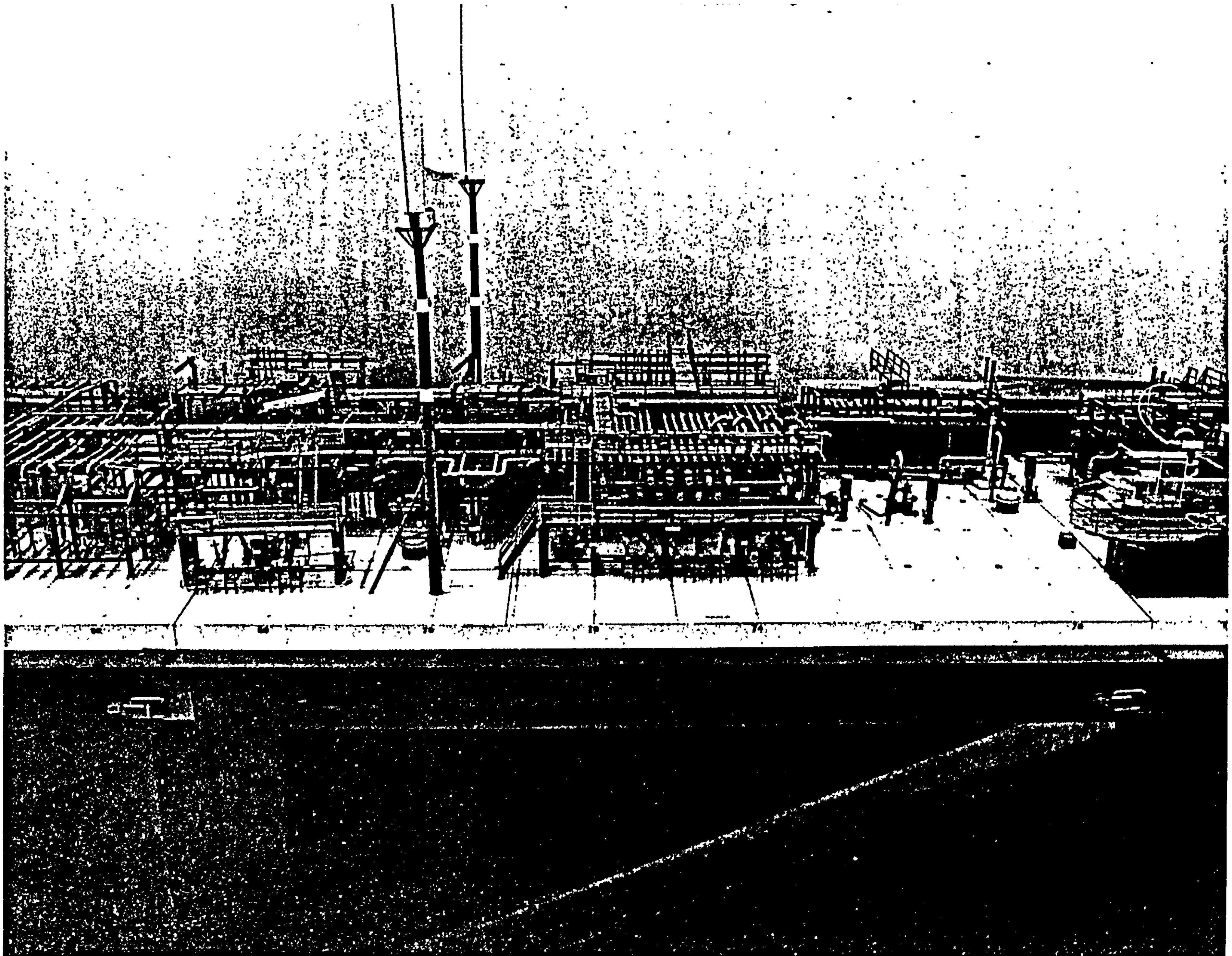
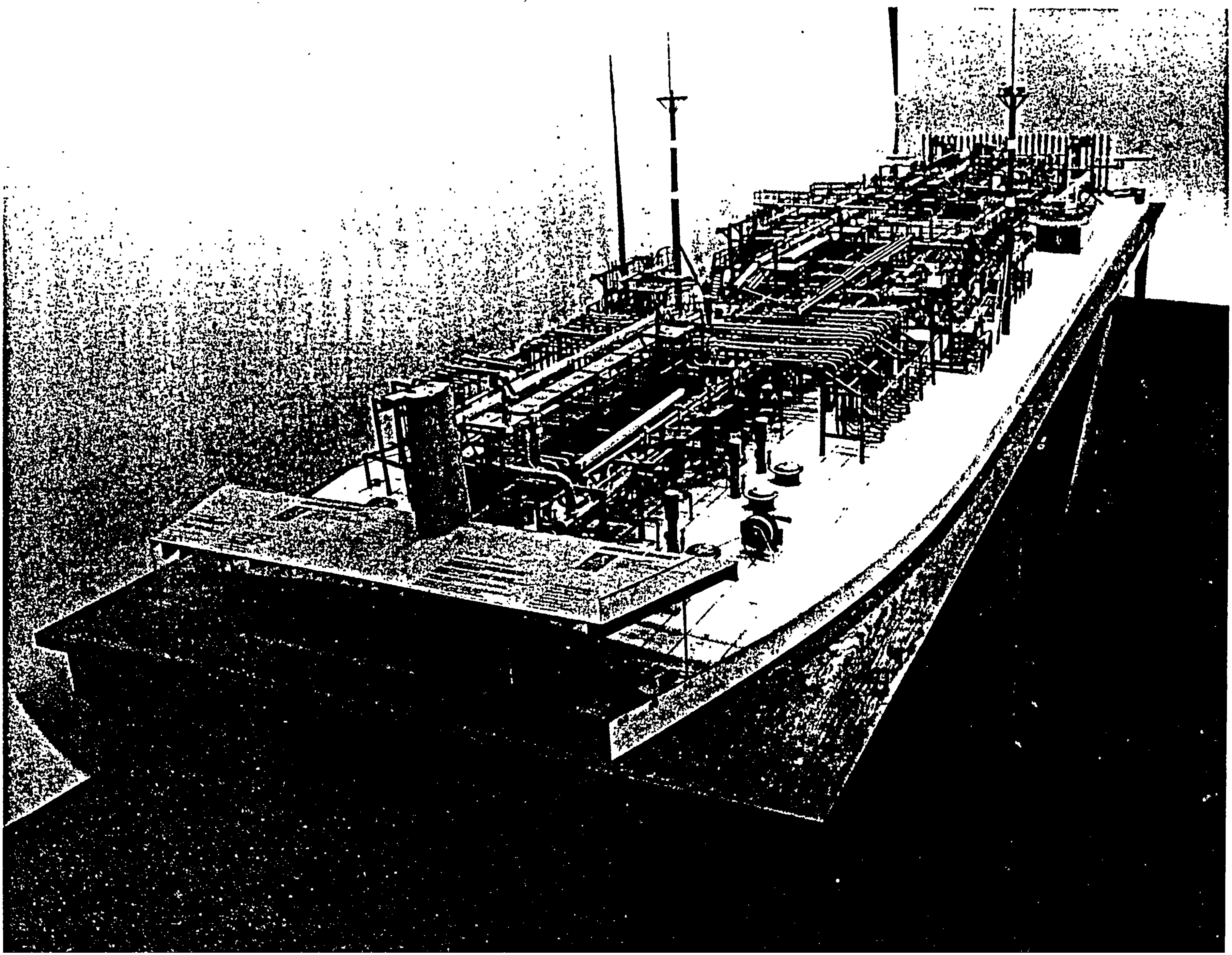


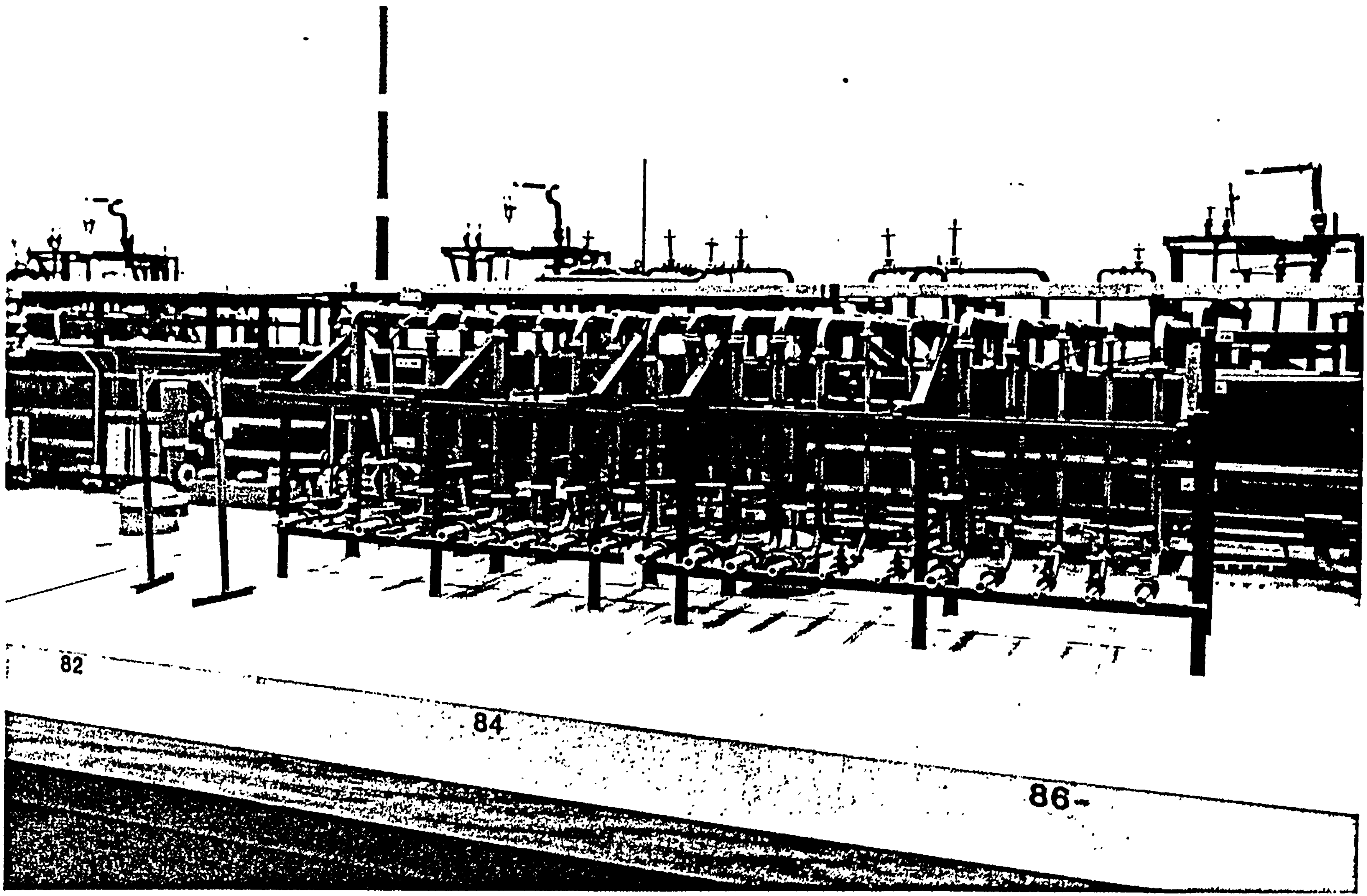


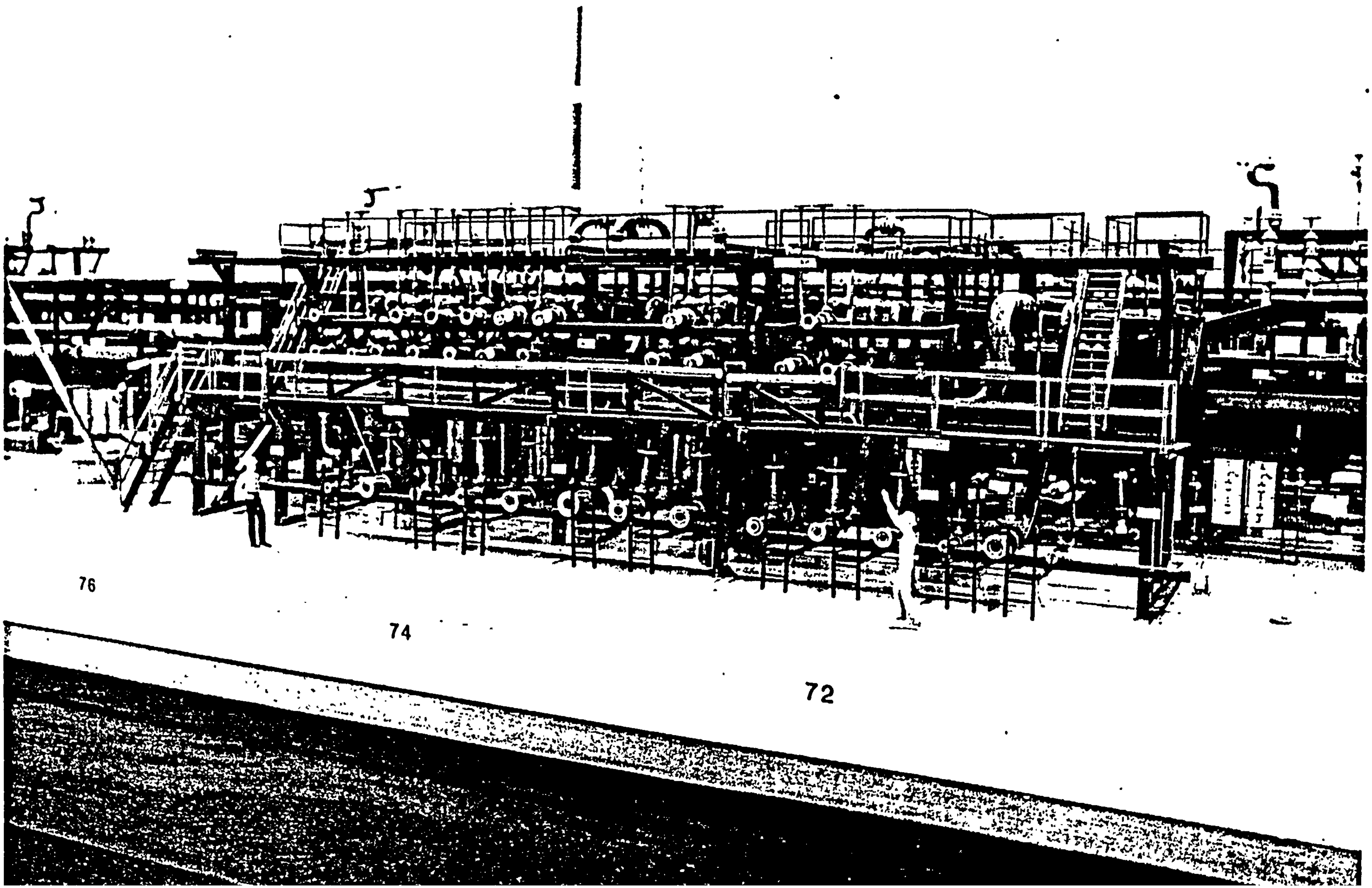
PH-26



PH-27




82
84
86


76
74
72

MN & HARBOR SEA WTR PUMPS - PKG UNIT	81-010-01V
MN ENGINE CROSSHEAD LUBE OIL PUMPS - PKG UNIT	81-M11-02X
MN ENGINE FUEL VALVE COOLING WTR PUMPS - PKG UNIT	81-M22-03X
E.R. BILGE/BALL PMP - PKG UNIT	81-M12-04X
DISTILLER EJECTOR PUMPS - PKG UNIT	81-M12-05X
INERT GAS SCRUBBER PMPS - PKG UNIT	81-M11-06X
MN ENGINE LUBE OIL SERVICE PMPS - PKG UNIT	81-M11-07X
MN ENGINE JACKET WTR PMPS - PKG UNIT	81-M21-08X
MN ENGINE PISTON COOLING PMPS/SEPARATOR - PKG UNIT	81-025-09V
L.O. TRANSFER PUMP - PKG UNIT	81-M12-10X
EXHAUST GAS & AUX BLR FEED PMPS - PKG UNIT	81-M21-11X
MN ENGINE F.O. PUMP & HTR SET - PKG UNIT	81-M22-12X
CONTROL AIR COMPRESSOR - PKG UNIT	81-M32-13X
DIESEL OIL TRANSFER & FUEL OIL TRANSFER PMPS PKG UNIT	81-008-14V
MN ENG AIR COOLER CHEMICAL CLEANING PMP & TK PKG UNIT	81-M11-15X
MN ENG WTR WASH PMP & HOT WTR PREP TK - PKG UNIT	81-025-16V
POTABLE WATER PUMP - PKG UNIT	81-M50-17X
MN & HARBOR FRESH WATER PUMPS - PKG UNIT	81-010-18V
MN SW/FW HEAT EXCHANGERS - PKG UNIT	81-010-19V
LUBE OIL PURIFIER VALVE MANIFOLDS - PKG UNIT	81-017-20V
AUX BOILER F.O. PUMP & HEATER SET - PKG UNIT	81-M22-22X
SLUDGE TRANSFER PUMP & L.O. PURIFIER FND PKG UNIT	81-017-23V
ENG RM BILGE/BALLAST PIPING - PKG UNIT	81-M12-24X
VACUUM PRIMING PKG UNIT	81-M22-25X
BOILER CHEMICAL FEED TANKS - PKG. UNIT	81-M21-26X
BOILER SLUDGE FEED PUMP - PKG UNIT	81-M22-27X
SHOWER/EYEWASH RECIRC. PUMP - PKG. UNIT	81-M41-28X

8	7	6	5	4	3	2	1

REFERENCES

NO	TITLE	DRAWING NO
1	WELD JOINT DETAILS BUTT	C1-15 PS-03-WJ-1
2	PAINTING SCHEDULE	C1-15 13-01-01
3	DOUBLE BOTTOM WING UNIT, FRS. 46-58 (P)	C1-15 00-008-008
4	DIAG. ENG. RM. BILGE & BALLAST SYS.	C1-15 68-01-10
5	PIPING MATERIAL SCHEDULE	C1-15 05-00-10
6	DIAG. MAIN SEA WATER COOLING SYS.	C1-15 68-05-10
7	GAGE BOARD, SIMPLEX & DUPLEX, 3½" & 4½"	A.S.I. STANDARD MS-05-99-1
8	SCH. OF POWER OPERATED VALVES	C1-15 05-30-06
9	LIST OF STRAINERS	C1-15 05-00-12
10	PIPING ARR'G'T. UNIT NO 8, 9 & 10 - PLAN VIEW - TANK TOP	C1-15 05-000-891
11	LIST OF GAGES	C1-15 87-00-01
12	PIPE JOINT PREPARATION & WELDING DETAILS	A.S.I. STANDARD NO 36
13	U-BOLT HANGER ASSEMBLY	A.S.I. STANDARD MS-16-UB-1
14	ENG RM. BILGE/BALLAST PUMP: PKG UNIT NO	C1-15 81-M12-097
15	BILGE STRAINER BOXES	A.S.I. STANDARD NO. 49
16	ENG RM. BILGE/BALLAST PUMP - PKG UNIT NO	C1-15 81-M12-086
17	POWER SYS. - DK PLAN - MACHY SPACE 33'-2" LVL & BELOW (GROUP CONTROL CENTERS)	C1-15 41-08-034
18	LIST OF SENSORS	C1-15 86-20-06
19	FUNNELS, ROUND AND OVAL	A.S.I. STANDARD NO. 33
20	DISTILLER EJECTOR PUMPS, PACKAGE UNIT	C1-15 81-M12-064
21		
22	CLAMP, CUSHIONED TEFLON	A.S.I. STD. MS-16-CC-1
23	DIAG STM SYS. & TK HTG. COILS, ENG RM	C1-15 68-10-13

INDEX

SH NO	TITLE
1	TITLE BLOCK, PRINT DISTRIBUTION, INDEX AND REFERENCES
2	GEN. NOTES & REVISIONS
3	PARTS LIST
4	KEY PLAN & GENERAL ARRANGEMENT
5	FOUNDATION DETAILS
6	FOUNDATION DETAILS
7	PIPING ARRANGEMENT
8	PIPING ARRANGEMENT
9	MISC. OUTFITTING DETAILS
10	CONTROL & INSTRUMENTATION ARR'G'T.
11	LABEL PLATE DETAILS
12	PIPE HANGERS & SUPPORTS
13	PIPE HANGERS & SUPPORTS

DISTRIBUTION

DEPARTMENT
PRODUCTION
PROD PLANNING
MOLD LOFT
PLANT ENGR & MAINT
ESTIMATING
PROGRAM MANAGER
QUALITY CONTROL
ELECTRICAL
ENGR STANDARDS
FILES & RECORDS
HULL
HULL COMPOSITE
DESIGN
OUTFITTING
INT. TANK
H V A C
MATERIAL ENGR
MECHANICAL
MECH COMPOSITE
ENGR PLAN & SCHED
BAYOU BLACK
HARVEY
SERVICE FOUNDRY
JOINER CONTRACTOR
ARMSTRONG
AMBAR (WAGES)
OWNER (HOME)
OWNER (YARD)
ABS (NY)
ABS (NO)
ABS (YARD)
USCG (NO)
USCG (YARD)
USPHS
TOTAL
PARTIAL ISSUE
DATE OF ISSUE

RESERVATIONS

NO	DESCRIPTION
2	~~RESERVE METHOD OF SUPPORTING FUEL OIL LINES, PEND. ISSUANCE OF STANDARD DETAIL.~~
1	~~[illegible]~~

THIS DRAWING CONTAINS MATERIAL WITH THE FOLLOWING PALLET CODES

PALLET CODE	DESCRIPTION	X
[illegible]	DURING SUB ASSEMBLY ... ON UNIT	
[illegible]	BEFORE TURNING DURING ON ASSY ... ON UNIT	
[illegible]	AFTER TURNING — PRIOR TO PAINT ... ON UNIT	
[illegible]	AFTER PAINT — PRIOR TO ERECTION ... ON UNIT	
[illegible]	AFTER JOINING W/OTHER UNITS — PRIOR TO ERECTION ... ON BLOCK	
[illegible]	BEFORE CLOSING IN ... ON BOARD	
[illegible]	EASY ACCESS OR ON OPEN DECK ... ON BOARD	
Z	FINAL OUTFITTING, FURNITURE, SPARE PARTS, LOOSE ITEMS, ETC. ... ON BOARD	
[illegible]	MATERIAL TO BE ROUTED TO BACK ASSEMBLY AREA	
[illegible]	MATERIAL TO BE ROUTED TO PACKAGE UNIT SHOP	
	MATERIAL TO BE ROUTED TO PIPE SHOP	
[illegible]	MATERIAL TO BE ROUTED TO TOP PIPE FABRICATION AREA	

REV

ASI DWG NO C1-15 81-M12-04X

RECORD INFO

SHT NO.	1	2	3	4	5	6	7	8	9	10	11	12	13
REV. NO.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

ASI HULL NO	NAME OF VESSEL
2337	
2336	
2335	

AVONDALE SHIPYARDS INC
P O BOX 50280
NEW ORLEANS, LA
70150

ASI JOB NO **C1-15**

EXXON COMPANY, USA

42,000 DWT MULTI-PRODUCTS CARRIE[R]

ENGINE ROOM BILGE/BAL[LAST]
PUMP - PACKAGE UNI[T]

DRAWN BY: Tom Turner | DATE
CHECKED BY: [signature] | DATE 11/[illegible]
APVD: [signature] 11/[illegible] MECH. ENGINEER
APVD: [signature] [illegible] ASST CHIEF ENGINEER
APVD: R.O. [signature] 1-12-72 PROGRAM MANAGER

SIZE D | ASI DRAWING NO C1-15 81-M12-0[illegible]

NOTED: EXXON NO. 420.06

TOTAL SHTS

8	7	6	5	4	3	2	1

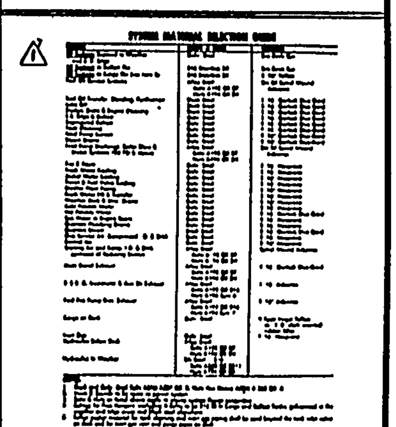
REVISIONS

SH	ZONE	DESCRIPTION
		APPROVED PER ESSI LETTER REF. 2335/7-42-PTC/665. DATED FEB 25.1987 WITH COMMENTS ON MARKED PRINT
.7 .7		1). RELOCATED SOUNDING TUBE IN PLAN 4-A, 7-A & 8-C. MODIFIED STRUCTURE PLAN 6-A & FLOOR PLAT. DETAIL 9-A TO SUIT.
7,8. 8 7-A.		2). ADDED STEAM LINE PD41-1½ & PD42-1½ IN PLAN 7-A, 8-C & 12-X & REVISED PIPE HANGER SECT 12-J & ADDED SECT. 12-U & 12-V ACCORDING. IN PARTS LIST CHGD QTY ITEM 51, 1½" U BOLT WAS (1) NOW (5)
11.		3). ADDED POWER OPERATOR IDENT. NOS. TO LABEL PLATE B,E,O,M,O, Q & S. IN LABEL PLATE LIST SH. 11.
8-A C		4). IN PARTS LIST CORRECTED ASI CAT. NO FOR ITEM 2,3 & 22 ADDED ASI CAT. NO TO ITEM 58
7,8 -C		5). ADDED LOW POINT DRAIN TO BILGE MAIN (PD3-A) IN PLAN 7-A & SECT B-B. - ADDED PLUG ITEM 116 TO PARTS LIST.
7		6). ADDED LOCATING DIMS TO 2½" VALVE FROM PURIF BILGE WELL & 6" VALVE FROM O.W HLDG TK. - PLAN 7-A
2		7). ADDED SYS. MTL. SELECTION GUIDE SH. 2. ALL ABOVE PER ENG DEVELOPMENT
		BY: CJS. 8/14/86 APVD:
7. 10.		1). RELOCATED GAGE BOARD 12" FURTHER OUTBOARD, REVISED OUTBOARD PUMP SUCT. PIPING FROM AFT PEAK AND ROLLED B'FLY VALVE ITEM 29 TO PROVIDE IMPROVED ACCESS TO GAGE BOARD.
2,13		2). ADDED PIPE SUPPORTS UNDER PUMP DISCH. VALVES & AT TERMINATION OF 5" OVERBD DISCH LINE (PD-38). ADDED NEW SHT #13 & DETS. 13-A, B & C
		3). INDICATED VAC PRIMING SYS. SHUT OFF VALVES ITEM #34 IN PLAN 7-A
		4). IDENTIFIED VAC. PRIMING SYS. ISO. VALVES ITEM 46 IN PLAN 8-E & VAC. PRIMING S.O VALVE 34 IN SECT B-C. - CORRECTED PICTURE OF PD36 IN PLAN 8-E & SECT B-C, WAS CONC. REDUCER NOW REDG INSERT.
		5). ADDED EXXON N3 TO TITLE BLOCK ABOVE REVISION PER ESSI REVD APPVL. COMMENTS
3C		6). LISTED REF #2 ADDED REF 22 & ITEM 120
		7) ADDED HYDRO TEST INFO FOR STEAM LINE TO G.N. B-10
2		8). ADDED G.N. B-11 & REF 21
3A		9) CHGD. QTY ITEM 6 FR 12 TO 3, ITEM 99 FR 12 TO 8, ITEM 100 FR 20 TO 16
11		10). CORRECT PC. MK. ITEM 47 FR ... TO ONOEE 2.1 PC. MK. 95 FR 122653 TO 1226...
6,8		11). ADDED ITEMS 117 THRU 120 & 112
6,6 8		12). INDICATED FIRE DAMPER REMOVAL AREA IN PLAN 4-A & REVISED STRUCTURAL & PIPING TO PROVIDE CLEAR DOWN IN WAY OF DAMPER REMOVAL AREA - ELEVS A, PLAN 6-A, PLAN 7-A, & SECT B-C
7,8		13). REVISED OUTBD PUMP SUCT VLV. POWER OPRTR TO 'STYLE B' USED APPVD. RIGHT HAND MOUNT & REORIENTATED TO PROVIDE ACCESS FOR SERVICE. PLAN 4 A, 7-A, SECT ...
		14) REVISED LIFT LUG DET S-H FOR 1 BOLTS WAS ...
		15). ADDED P/D IDENT. TO ELEV B-H & 17" VLAT ...
3 1A 3C		16) LISTED REF #1 ADDED ...
		REV. 1 & 2 APPVD. BY ESSO INT. PER LTR. OF 9-18-89, REF. 2331/1-480-PTC/665 — BY: CJS 3/15/88 APVD

REVISIONS

REV	SH	ZONE	DESCRIPTION
	1,2 7		1) DELETED REF. 21; DELETED GEN. NOTE B-11 & IN PLAN VIEW 7-A, DELETED INSULATION FROM 1½" STEAM SUPPLY LINE (INSUL. NOT REQ'D. IN BILGE)
	1		2) ADDED REF 23.
	2		3) IN G.N. B-5, CHGD FROM NEOPRENE GASKET TO COMPRESSED NON ASBESTOS PER REF 3 OF REF 5.
	3 3A 3B 3C		4) IN PARTS LIST: REV. QTY. OF ITEMS 2,3,66,67,68, 69, TO 2, 113; REV A.S.I. CAT. NO. OF ITEMS 3, 13 & 111; REV. SO. OF ITEM 13 FROM 1½" TO 1¼"; REV. SIZE OF ITEM 88 FROM 4½" TO 4¼"; REV DESCRIPTION OF ITEM 111 FROM SCH. 80 TO CLASS 200; REV MAT'L. OF ITEM 67,68,69 & TO M STL & STN STL; ADDED ITEM 121.
	6		5) IN PLAN 6-A, ADDED TUC ..., PC. 6 & IN SECT. 6-C. INDICATED CONT. WELD IN LIEU OF INTERMEDIATE
2	8		6) IN PLAN VIEW 8 D, ADDED UNION, P...113.
	9		7) IN LIST OF PLR A. TAB, REV SIZE OF PC. 8 & 9.
	10		8) IN DET. 10 E, DELETED PIN @ HANDWHEEL ADAPTER & INDICATED SHEET WELD.
	12		9) IN SECT 12-B, CORRECTED SUPPORT LOC. FROM 2'1½" TO 2'2¼". ITEMS 1 THRU 9 ABOVE AS A DEVELOPMENT.
	8 6 9		10) IN DET. 8-A, INDICATED MISSED ... AT PLATE MARKED "U", ADDED DETAIL 8-A, SECT 8-F & 8B; ADDED ... SUPPORT, PC. 3, IN PLAN 6-A & ADDED SECT 6-H; ALSO REV GEN. ARR'G. PLAN VIEW 4-A, TO SUIT.
	4		11) IN PLAN 8-A, CORRECTED ORIENTATION OF VALVE HANDLES IN 6" LINE FROM SEA CHEST TO ABAFT IN PLAN 7-A. ITEMS 10 & 11 ABOVE TO SUIT ESSO INT. APPROVAL OF REV 2.
	2		12) IN ...
			BY: ... APVD ... 5-10-88

SYSTEM MATERIAL SELECTION GUIDE



GENERAL NOTES

(A) FOUNDATION & MISC. NOTES

1) ALL SHARP CORNERS TO BE GROUND SMOOTH.
2) UNLESS OTHERWISE NOTED ALL SNIPES TO BE 3/4" x 3/4" AND SEAL WELDED AFTER FABRICATION.
3) ALL BOLT HOLES FOR MOUNTING EQUIPMENT TO BE TEMPLATED FROM EQUIPMENT AT INSTALLATI[ON]
4) ALL WELDING TO BE IN ACCORDANCE WITH REF. NO. 1 & APPLICABLE A.B.S. RULES.

(B) PIPING NOTES

1) FOR PIPING DIAGRAM, SEE REF NO 4.
2) FOR PIPING MATERIAL SCHEDULE, SEE REF NO. 2.
3) FOR PIPING P/O, SEE REF NO 16. FOR ORDERING INFORMATION, SEE REF. 16.
4) ALL BOLTS AND NUTS, ¾" DIA. AND BELOW, USED TO CONNECT PIPING, SHALL BE SCREENED FROM STOCK BY MATERIAL CONTROL.
5) BOLT MATERIAL IS TO BE ASTM A 307, GRADE B, GALV.; NUT MATERIAL IS TO BE ASTM A 307, GRADE B, GALV. GASKET MATERIAL IS TO BE 1/16" OIL RESISTANT COMPRESSED NON ASBESTOS
6) ALL PIPING TO BE INSTALLED IN ACCORDANCE WITH APPLICABLE RULES & REGULATIONS OF A.B.S. & U.S.C.G. F[OR] CLASS III PIPING.
7) WHERE ... SCL. PIPE BENDS SHALL BE AS FOLLOWS: BELOW 2" - 3 x NOM. DIA.; 2" THRU 4" - 2 x NOM. DIA.; 5" & 6" - 2½ x NOM. DIA.
8) WELDING TO BE IN ACCORDANCE WITH REF NO 12.
9) ALL PIPING & PIPING APPURTENANCES SHALL BE THOROUGHLY CLEANED AFTER FABRICATION & PRIOR TO INSTALLATION ON PACKAGE.
10) PRIOR TO INSTALLATION OF PKG UNIT ABOARD SHIP, THE BILGE/BAL. SYS. IS TO BE HYDROTESTED AT ... DURING TEST, ALL VALVES ARE TO BE IN THE OPEN POSITION, EXCEPT AT SEA WATER CONNECTIONS, IN ORDER CHECK CORRECT ORIENTATION OF STOP CHECK VALVES. DO NOT BLANK OFF BILGE SUCTION & SEPARATOR SUCTION P... HYDRO STM. LINE AT 225 PSI.
11) PIPING 1" DIA & BELOW IS NOT DETAILED ON REF. 16, THIS PIPING IS TO BE FIELD RUN AS CLOSE AS PRACTICAL TO THE ROUTING SHOWN ON THIS DRAWING.
12) ALL SCREW & STOP CHECK VALVES BELOW GRATING (EXCEPT STRAINER DRAIN VALVES) SHALL BE FITTED WITH H[AND] WHEEL EXTENSION STEMS - SEE SHT 8 & DETAIL 10-E.

(C) PAINTING & LABEL PLATES

1) STEEL TO BE PAINTED IN ACCORDANCE WITH REF. NO. 2, SH. NO. 46, LINE NO. 4 & SH NO. 47, LINES 1-4.
2) PIPING TO BE PAINTED IN ACCORDANCE WITH REF NO 2, SH. NO. 53, LINE NO 9
3) ARROWS ... STENCILED ON PIPING TO INDICATE FLOW DIRECTION.
4) ALL PAINTING TO BE COMPLETE AND LABEL PLATES INSTALLED PRIOR TO INSTALLATION OF PACKAGE ON SHIP
5) SEE SH. 11 FOR ADDITIONAL NOTES CONCERNING LABEL PLATES.

(D) PREPARATION FOR SHIPMENT & INSTALLATION ABOARD SHIP

1) TO FACILITATE HANDLING OF PACKAGE, PD 6-8" ... PORT FWD BILGE SUCTION WELL SHOULD BE SHIPPED LOOSE. AFTER PACKAGE IS INSTALLED ON SHIP THIS LINE MUST BE POSITIONED AS SHOWN IN SECT. "B-B" OF THIS DRAWING.
2) SOUNDING T... FOR ... VOID TO BE SHIPPED LOOSE WITH PACKAGE AND INSTALLED AFTER PACKAGE ... IN FINAL POSITION ON SHIP.
3) OPEN PIPE ENDS TO BE BLANKED OFF BEFORE PACKAGE LEAVES SHOP.
4) SHOP TO PROVIDE ADEQUATE PROTECTION (PLYWOOD OR OTHER SUITABLE MATERIAL) FOR GAGES AND OTHE[R] VULNERABLE EQUIPMENT TO PREVENT DAMAGE DURING SHIPPING AND FINAL HOOK UP ABOARD SHIP.
5) HANDLE PACKAGE WITH CARE. DO NOT LIFT PACKAGE FROM PIPING OR EQUIP. USE ONLY DESIGNATED LIFTIN[G] POINTS AS SHOWN ON THIS DRAWING. SEE SHT. 6. RETAIN THE TWO BOLTED PADEYES TO PACKAGE SHOP REUSE AFTER PACKAGE IS INSTALLED ABOARD VESSEL. DO NOT CUT OFF BUILT-IN LIFTING PADS.
6) P... IS TO BE LOCATED ABOARD VESSEL PER SH 4 AND SECURED PER ELEV. "S-A" OF THIS DRAWING
7) FOUNDATION TO BE SET LEVEL TO BASELINE OF SHIP, SCRIBE LEGS & CUT AS REQUIRED
8) FOUNDATION PADS ARE LOCATED PER REF 10

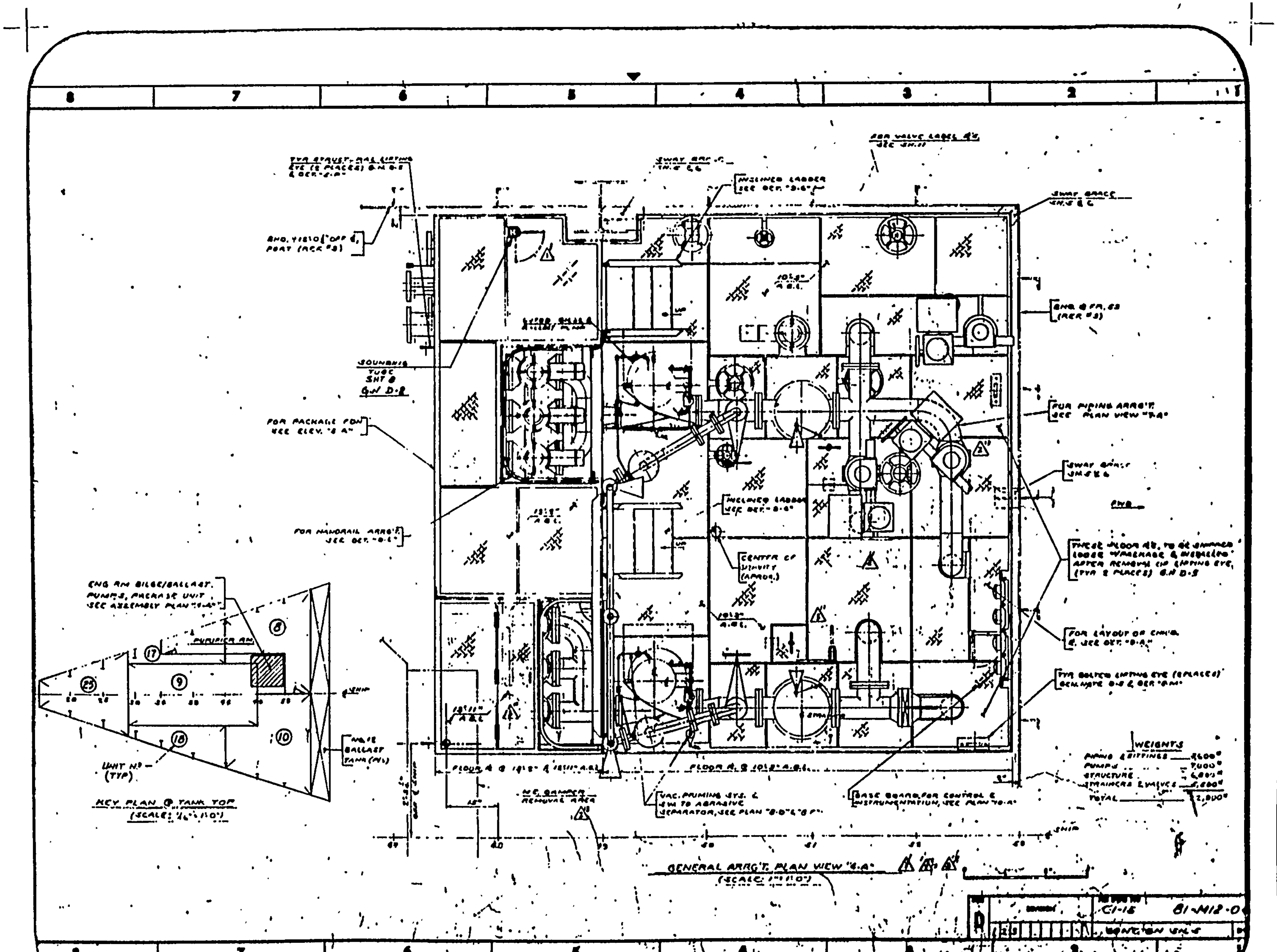
SIZE	REVISION	DWG NO	
D	- 1 2	C1 15	81-M12-0
		CONT. ON SH 3	

8	7	6	5	4	3	2	1

PARTS LIST (QUANTITIES FOR ONE VESSEL) FOR ORDERING INFO. SEE SEPARATE LIST OF MATERIAL - REF. 16

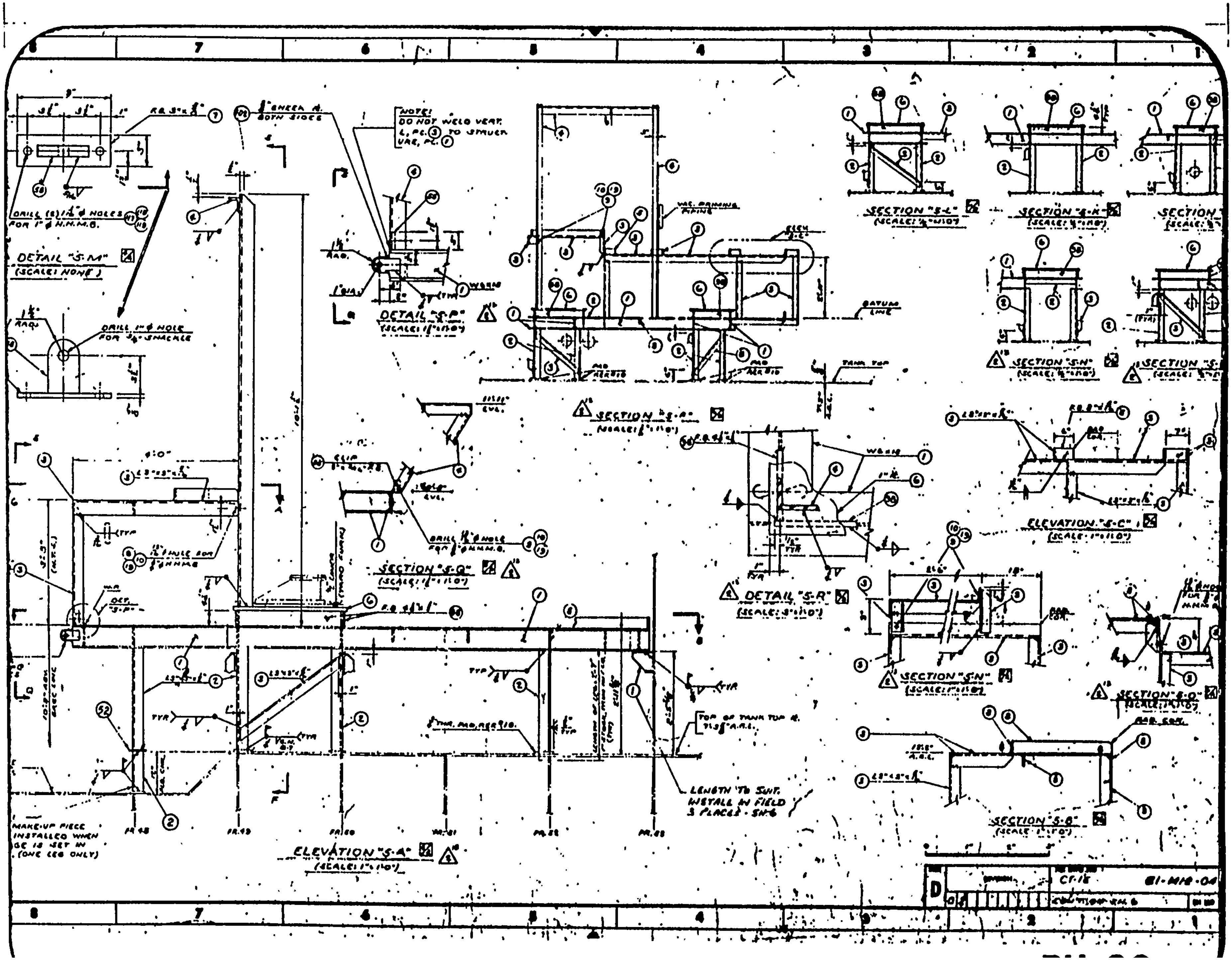
QTY	DESCRIPTION	ASI CATALOG NO.	MATERIAL	SPEC. ORDERING DATA	REMARKS
90 L/F	W6 x 15	———	STEEL	ASTM A-36	CUT TO SUIT ORDERED ON REF. NO.
50 L/F	ANGLE, 3" x 3" x 3/8"	[illegible]			
170 L/F	ANGLE, 3" x 3" x 5/16"	[illegible]			
31 L/F	ANGLE, 3" x 4" x 5/16"	[illegible]			
34 L/F	FLAT BAR 3" x 5/16"	[illegible]			
1	PLATE, 1" THICK x 36 x 4'-8" LG. SEE REMARKS	2ABA06241		A.B.S. GR.A	CUT [illegible]
2 L/F	FLAT BAR, 3" x 3/8"	2ABA00943			CUT TO SUIT
8	MACHINE BOLT, 3/8" DIA. HEX. HD. 16-UNC-2A x 3" LONG	[illegible]	STEEL GALV.	COMMERCIAL	
12	HEX. NUT, 3/8" DIA. 16UNC-2B	[illegible]	STAINLESS STEEL	TYPE 316	
12	LOCK WASHER, 3/8" DIA. SPRING TYPE	[illegible]		COMMERCIAL	
8	MACHINE BOLT, 3/8" DIA. HEX. HD. 16 UNC-2A x 1" LONG	[illegible]	STEEL GALV.		
16	HEX. NUT, 3/8" DIA. 16UNC-2B	[illegible]			
16	LOCK WASHER, 3/8" DIA. SPRING TYPE	[illegible]			
4	FLAT BAR 3" x 3/8" x 4 1/2" LONG (EACH)	[illegible]	STEEL	ASTM A-36	
166 SQ FT	8.7# DIAMOND PLATE (FOR CUT SIZE OF PLATES, SEE TABULATION ON SH 8)	——			
46 L/F	1 1/4" DIA STD PIPE ASTM A-120 GR A [illegible]	[illegible]			CUT & BEND TO SUIT
14 L/F	C6 x 8.2	——			CUT TO SUIT
4	FLAT BAR [illegible] x 3/8" x 3 1/2" LONG (EACH)	[illegible]			FOR CLIPS FOR LADDER
12	MACHINE BOLT, 3/8" DIA. HEX. HD., 16UNC 2A x 1 1/2" LONG	[illegible]	STAINLESS STEEL	TYPE 316	
2	"U-BOLT" FOR [illegible]" DIA PIPE, TYPE 2 PER REF 13	[illegible]	STEEL GALV.	ASTM A 36	
14 L/F	ROD, 1" DIA	[illegible]	STEEL		CUT & BEND TO [illegible]
30 L/F	FLAT BAR, 2 1/2" x 3/8"	[illegible]			CUT TO SUIT
16	MACHINE BOLT, 3/8" DIA. HEX. HD., 16 UNC-2A x 1 1/2" LONG	[illegible]	STEEL GALV.	COMMERCIAL	
110 L/F	ANGLE, 2" x 2" x 5/16"	[illegible]	STEEL	ASTM A-36	CUT TO SUIT
136	MACHINE SCREW, 3/8 DIA PAN HD. 16UNC-2A x 5/8" LONG	10100011	BRASS	COMMERCIAL	
2	BILGE/BALLAST PUMP, WARREN PUMP [illegible] 1/2 H.P. MOTOR	——	VARIOUS		ORDERED ON P.O. NO. [illegible]
7	3" VALVE, STOP CHECK GLOBE, IRON DUCTILE FLG. 150# BRZ. TRIM	053613			
1	6" VALVE, BUTTERFLY, IRON DUCTILE-HYCAR LINED, 150#. 19 1/2" EXTENSION FROM ℄ VALVE TO HANDLE. LUG TYPE - DRILLED & TAPPED.	054186			
1	6" VALVE, BUTTERFLY, IRON DUCTILE 150# WAFER TYPE [illegible] EXTENSION FROM ℄ VALVE TO HANDLE	054184			
1	6" VALVE, BUTTERFLY, IRON DUCTILE, 150# WAFER TYPE.	053154			
1	1 1/2" VALVE, STOP CHECK GLOBE, BRZ. 150#, BRZ. TRIM, IRON BONNET	[illegible]			
1	2" VALVE STOP CHECK GLOBE, IRON DUCTILE FLG., 150# BRZ. TRIM	053922			
2	2 1/2" VALVE, STOP CHECK GLOBE, IRON DUCTILE FLG., 150# BRZ. TRIM	053913			
2	2" VALVE, GATE, IRON DUCTILE FLG, 150# BRZ. TRIM	[illegible]			
2	1 1/4" x 3/16" PRIMING VALVE,	——	BRONZE		FURNISHED WITH VACUUM PRIMING SYS. ORDERED ON PO

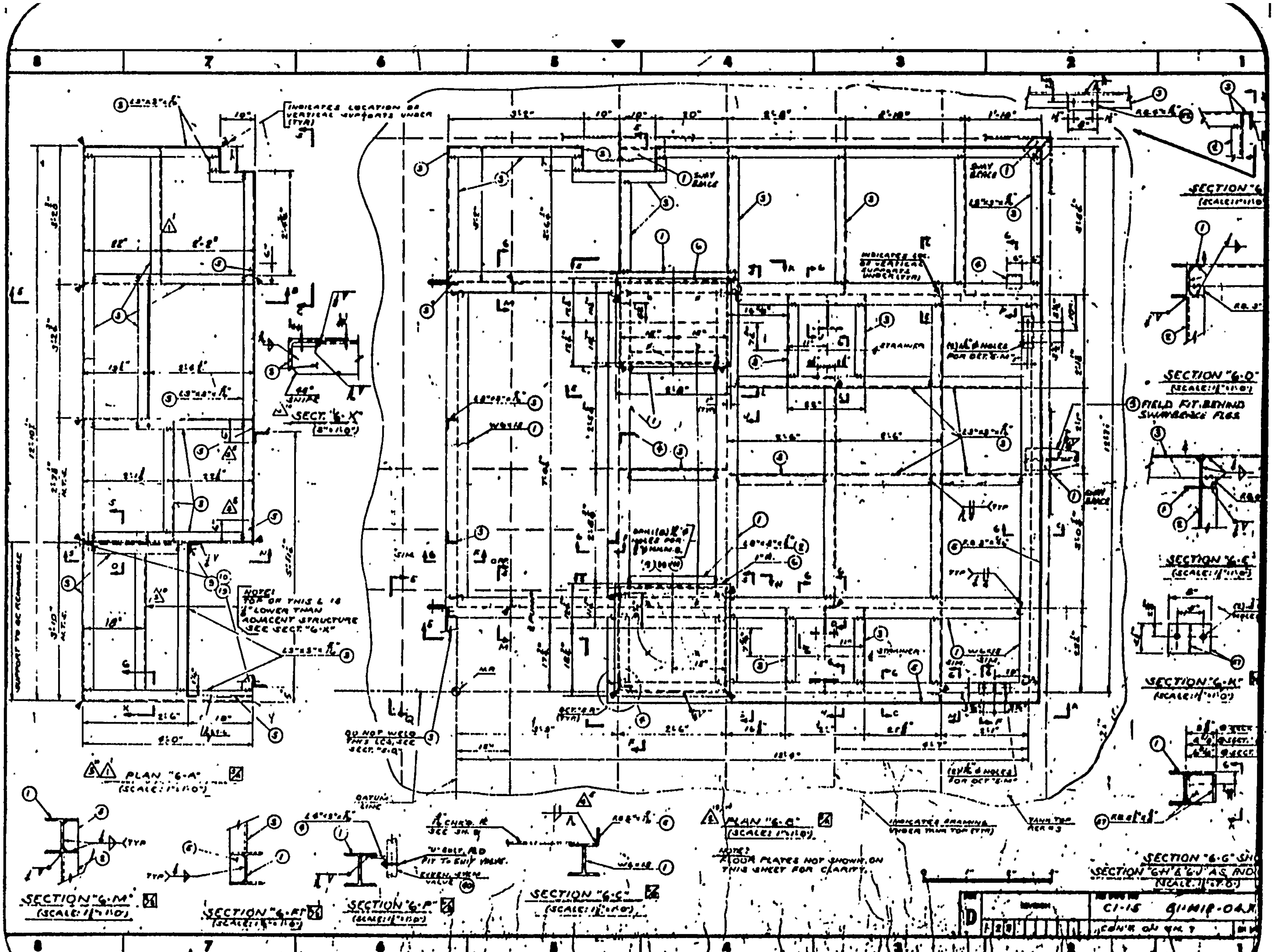
D — CI-13 — 81-MID[illegible] — CON'T ON [illegible]



GENERAL ARRG'T. PLAN VIEW "G-A"
KEY PLAN @ TANK TOP
WEIGHTS
CENTER OF GRAVITY (APPROX.)

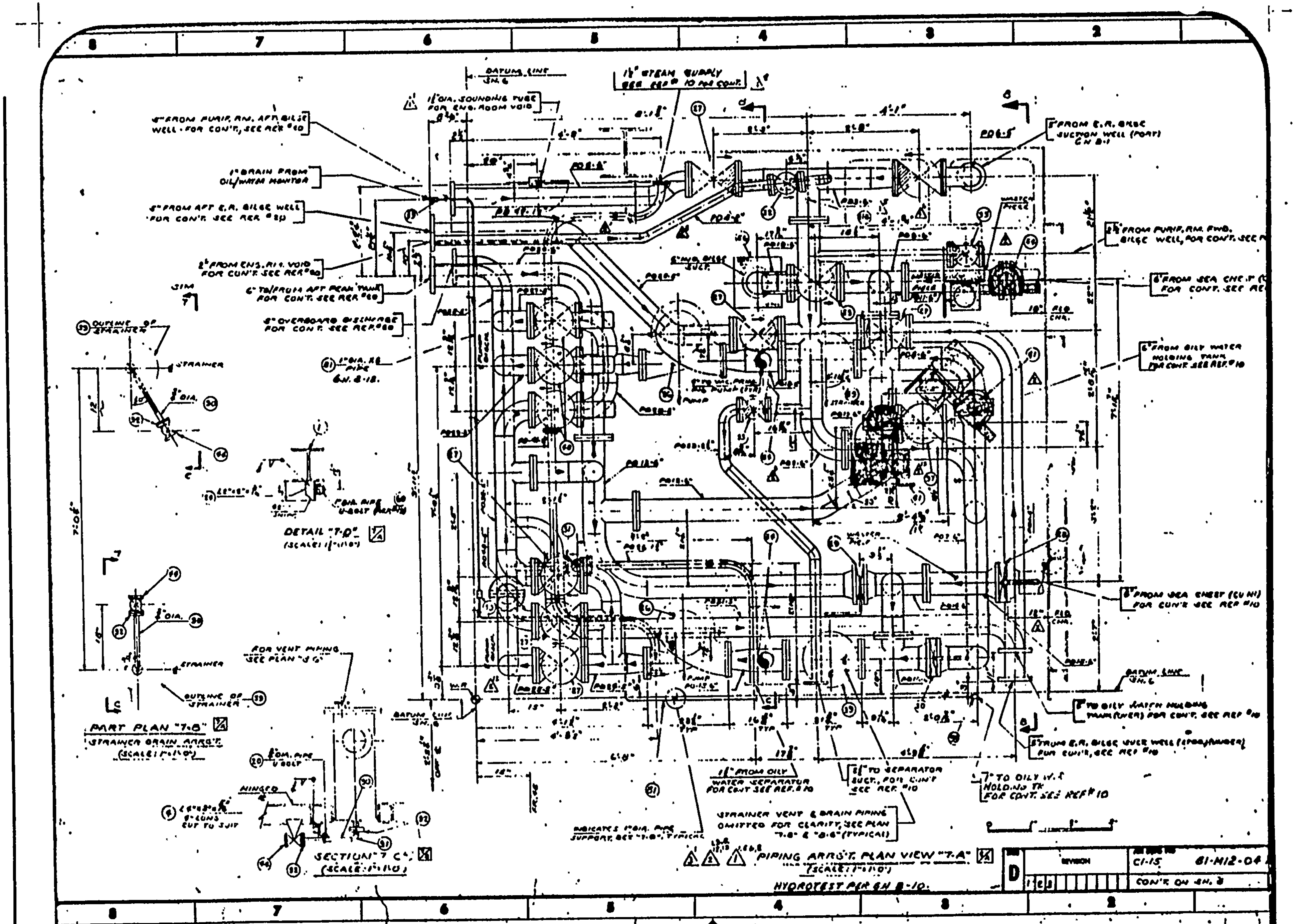
PH-35


DETAIL "S-M"
(SCALE: NONE)
NOTE: DO NOT WELD VERT. L, PC. 3 TO STRUCTURE, PC. 1
DETAIL "S-P"
SECTION "S-A"
SECTION "S-L"
SECTION "S-N"
SECTION "S-Q"
DETAIL "S-R"
ELEVATION "S-C"
SECTION "S-O"
SECTION "S-B"
LENGTH TO SUIT. INSTALL IN FIELD 3 PLACES - SH-6
ELEVATION "S-A"
(SCALE: 1"=1'-0")
D
CF-15



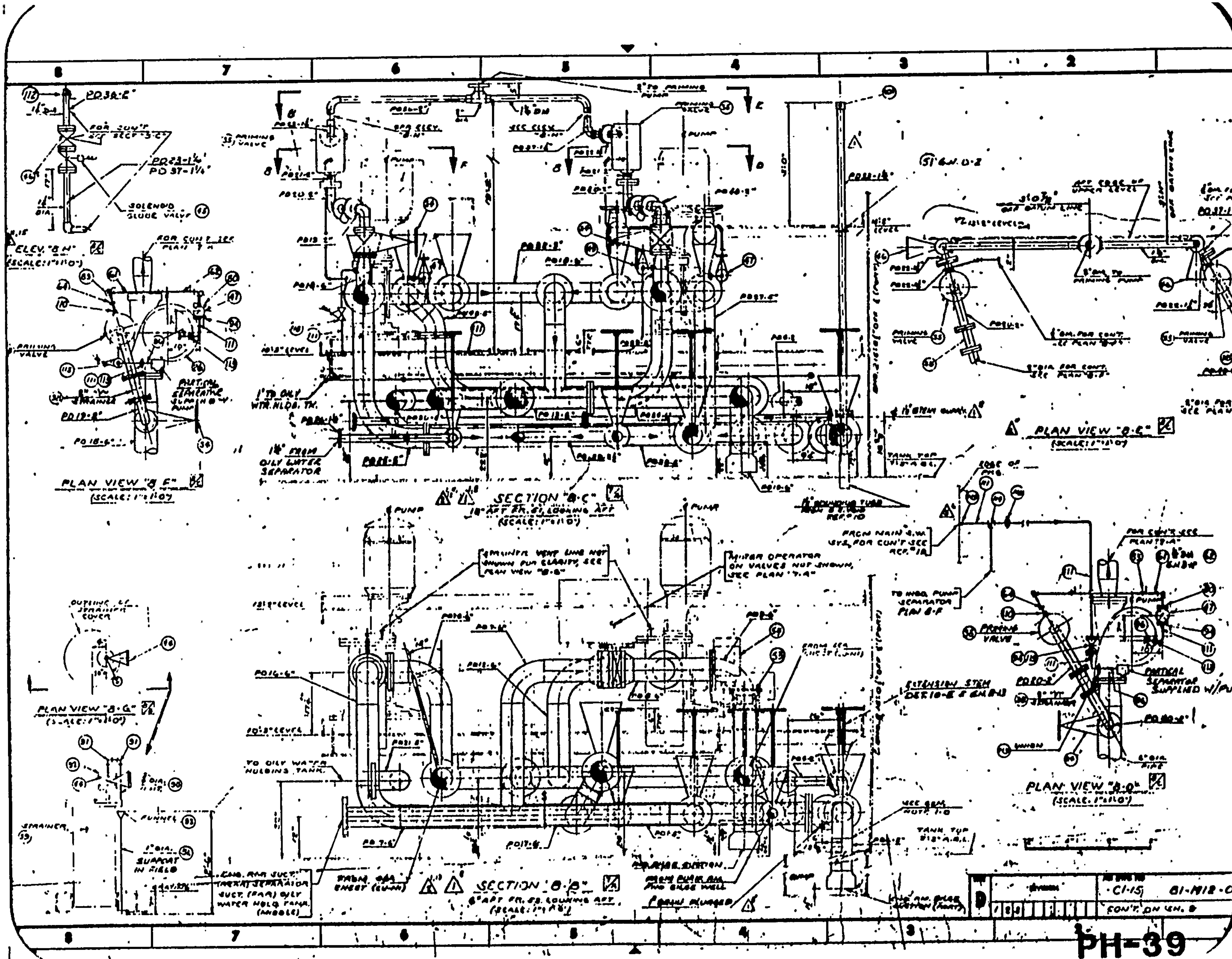
PLAN "6-A"
(SCALE: 1"=1'-0")
PLAN "6-B"
SECTION "6-M"
SECTION "6-R"
SECTION "6-P"
SECTION "6-C"
SECTION "6-D"
SECTION "6-E"
SECTION "6-K"
SECT. "6-X"
INDICATES LOCATION OF VERTICAL SUPPORTS UNDER (TYP.)
NOTE: TOP OF THIS ℄ IS ½" LOWER THAN ADJACENT STRUCTURE SEE SECT. "6-X"
DO NOT WELD THIS LOC. SEE SECT. "6-Q"
DATUM LINE
FIELD FIT BEHIND SWAYBRACE FLGS.
STRAINER
SWAY BRACE
NOTE: FLOOR PLATES NOT SHOWN ON THIS SHEET FOR CLARITY.
INDICATES FRAMING UNDER TANK TOP (TYP)
C1-15

PH-37



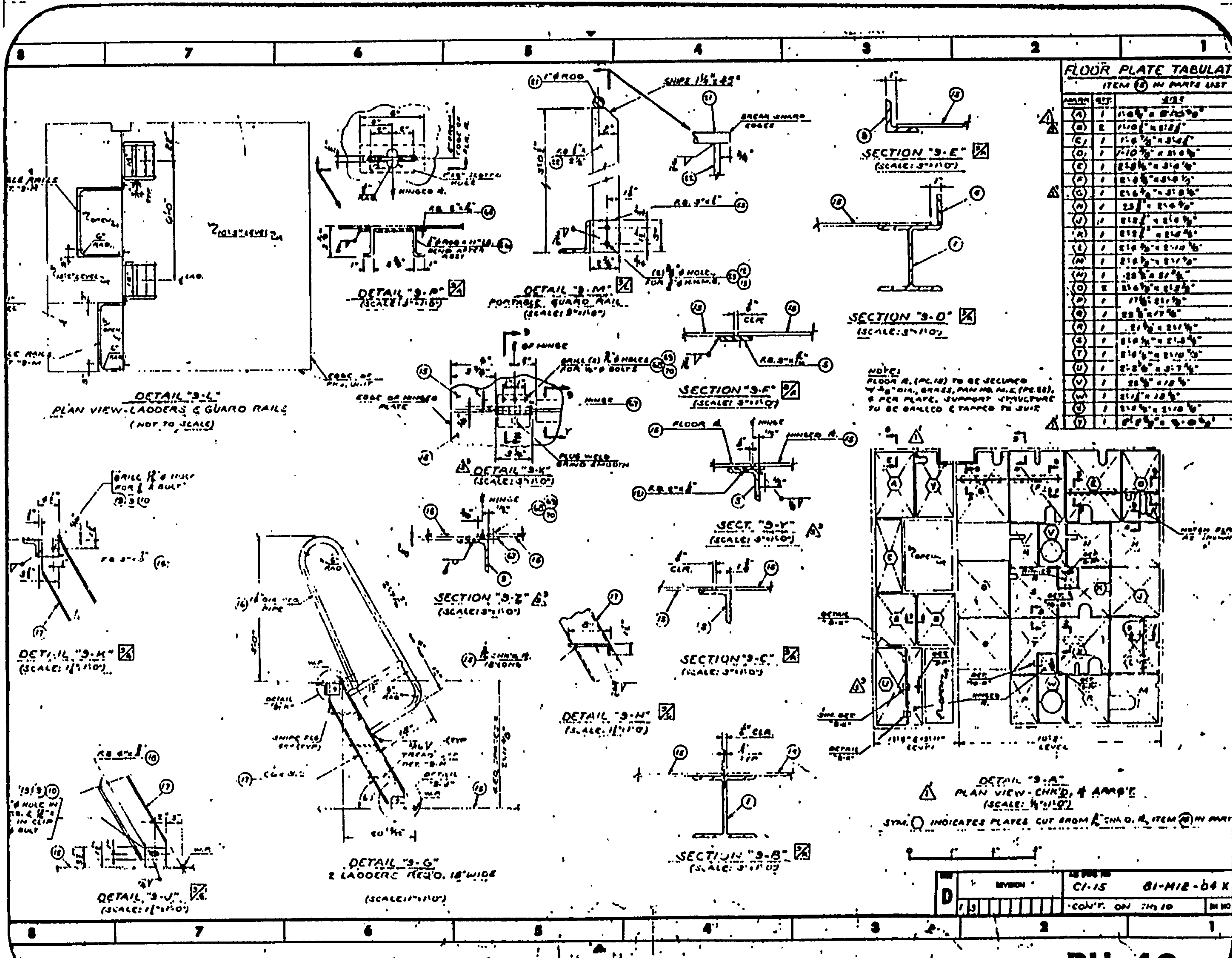
PIPING ARR'G'T. PLAN VIEW "7-A"
HYDROTEST PER SH 8-10
PART PLAN "7-B"
STRAINER DRAIN ARR'G'T.
DETAIL "7-D"
SECTION "7-C"
DATUM LINE
CI-15
61-M12-04

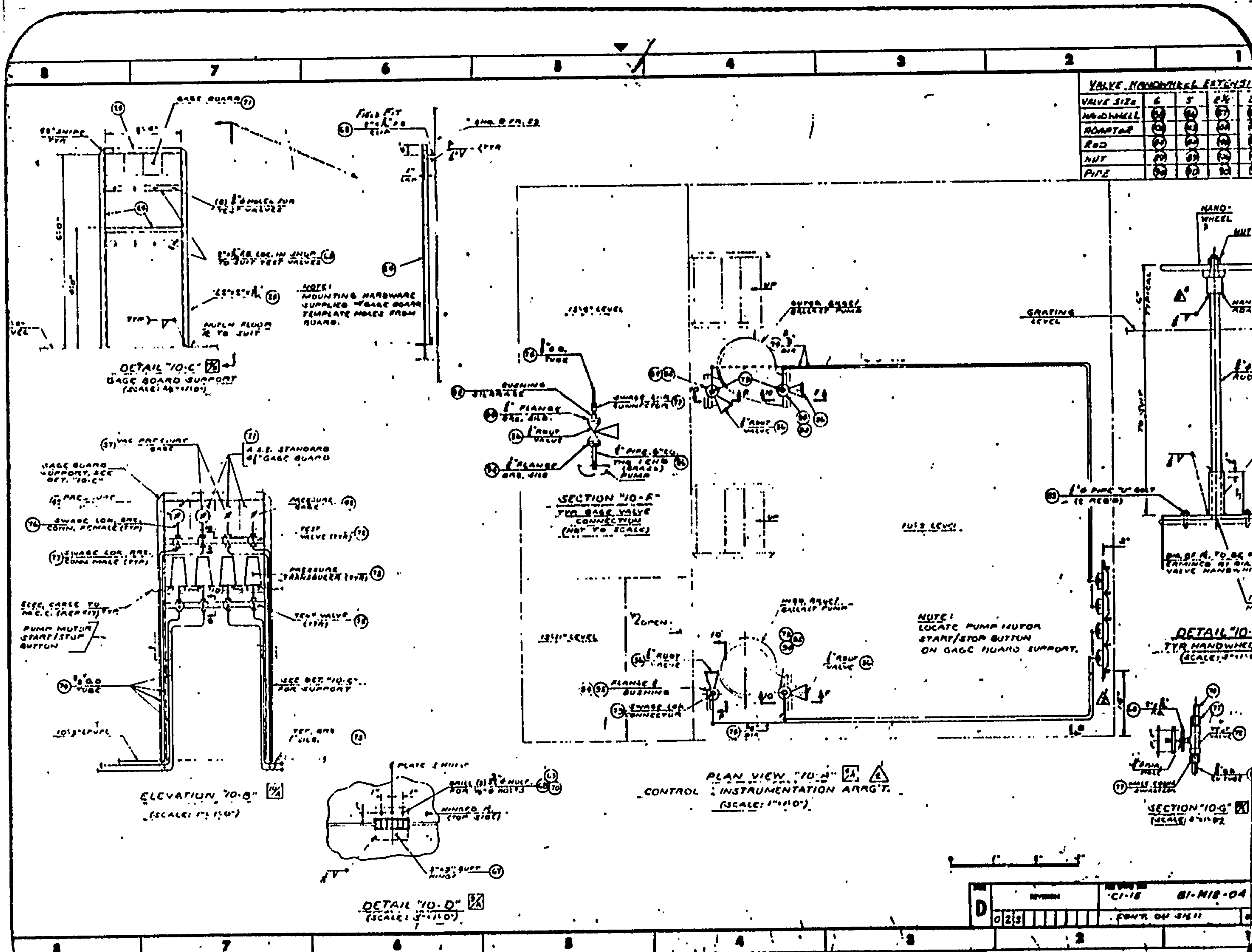
PH-38



ELEV. "B-H"
PLAN VIEW "B-F"
SECTION "B-C"
PLAN VIEW "B-E"
PLAN VIEW "B-G"
SECTION "B-B"
PLAN VIEW "B-D"
SOLENOID SLUDGE VALVE
STRAINER
FUNNEL
SUPPORT IN FIELD
TANK TOP
EXTENSION STEM

PH-39


FLOOR PLATE TABULATI
DETAIL "9-L"
PLAN VIEW-LADDERS & GUARD RAILS
(NOT TO SCALE)
DETAIL "9-P"
DETAIL "9-M"
PORTABLE GUARD RAIL
SECTION "9-E"
SECTION "9-D"
SECTION "9-F"
DETAIL "9-K"
SECT. "9-Y"
SECTION "9-Z"
DETAIL "9-H"
SECTION "9-C"
DETAIL "9-G"
2 LADDERS REQ'D. 18" WIDE
DETAIL "9-J"
SECTION "9-B"
DETAIL "9-A"
PLAN VIEW-CHK'D. & ARR'G'T.
D

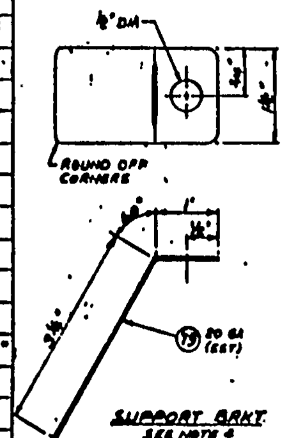


VALVE HANDWHEEL EXTENSI
VALVE SIZE
HANDWHEEL
ADAPTOR
ROD
NUT
PIPE
DETAIL "10-C"
GAGE BOARD SUPPORT
NOTE:
MOUNTING HARDWARE SUPPLIED W/GAGE BOARD TEMPLATE HOLES FROM BOARD.
SECTION "10-F"
TYP GAGE VALVE CONNECTION
(NOT TO SCALE)
GRATING LEVEL
NOTE:
LOCATE PUMP MOTOR START/STOP BUTTON ON GAGE BOARD SUPPORT.
DETAIL "10-
TYP HANDWHEEL
ELEVATION "10-B"
PUMP MOTOR START/STOP BUTTON
DETAIL "10-D"
PLAN VIEW "10-A"
CONTROL INSTRUMENTATION ARRG'T.
SECTION "10-G"
C1-15
81-M12-04

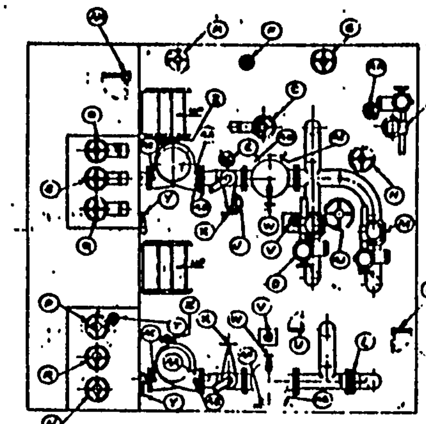
PH-41

LIST OF LABEL PLATES

LABEL MARK	QTY.	TYPE	MATERIAL	INSCRIPTION	ITEM DESCRIPTION	REMARKS
A	1	II	ALUM.	INBD BILGE/BAL PMP SW SUCT	6" BUTTERFLY VLV.	WIRE LABEL PLATE TO VALVE FOR SHIPMENT, FINAL LOCATION TO BE ON ADJACENT BHD.
B	1	I		OUTBD BILGE/BAL PMP SW SUCT BAL-PVHO	RO.	LOCATE LABEL PLATE ON FLAT SURFACE OF POWER OPERATOR.
C	1	I		INB BILGE SUCT BAL-PVOB		
D	1	I		OUTBD BILGE/BAL PMP AFT PEAK TK SUCT BAL-PVOB		
E	1	II		AFT ENG RM DRAINWELL BILGE SUCT	5" STOP CHECK VLV.	WIRE LABEL PLATE TO VALVE FOR SHIPMENT, FINAL LOCATION TO BE ON ADJACENT BHD.
F	1	I		ENG RM VOID BILGE SUCT	2"	
G	1	I		PORT ENG RM DRAINWELL BILGE SUCT	2"	
H	1	I		STBD ENG RM DRAINWELL BILGE SUCT	2"	MOUNT TO SUPPORT BRKT. DET. 11-C (NOTE 4)
J	1	I		OILY WATER SEP BILGE SUCT	2½"	
K	1	I		PURIFIER RM AFT BILGE SUCT.	2"	
L	1	I		INBD BILGE/BAL PMP MAIN BILGE SUCT	6" BUTTERFLY VLV.	LOCATE LABEL PLATE ON VALVE LEVER, PLATE TO CONFORM TO CONTOUR OF LEVER.
M	1	I		OUTBD BILGE/BAL PMP MAIN BILGE SUCT BL-PVOH	6" RO.	LOCATE LABEL PLATE ON FLAT SURFACE OF POWER OPERATOR.
N	1	I		INBD BILGE/BAL PMP OVBD DISCH	8" STOP CHECK VLV.	MOUNT TO SUPPORT BRKT. DET. 11-C (NOTE 4)
O	1	I		OUTBD BILGE/BAL PMP OVBD DISCH BL/BAL-PVOB	8" RO.	LOCATE LABEL PLATE ON FLAT SURFACE OF POWER OPERATOR.
P	1	I		INBD BILGE/BAL PMP DISCH TO AP TK	8"	MOUNT TO SUPPORT BRKT. DET 11-C (NOTE 4)
Q	1	I		OUTBD BILGE/BAL PMP DISCH TO AP TK BAL-PVOA	8" RO.	LOCATE LABEL PLATE ON FLAT SURFACE OF POWER OPERATOR.
R	1	I		INBD BILGE/BAL PMP DISCH TO OW HOLDING TK	8"	MOUNT TO SUPPORT BRKT. DET. 11-C (NOTE 4)
S	1	I		OUTBD BILGE/BAL PUMP DISCH TO OW TK BIL-PVOB	8" RO.	LOCATE LABEL PLATE ON FLAT SURFACE OF POWER OPERATOR.
T	1	I		OILY WATER SEP OVBD DISCH	1½" STOP CHECK VLV.	MOUNT TO SUPPORT BRKT. DET 11-C (NOTE 4)
U	1	I		INBD BILGE/BAL PMP AFT PEAK TK SUCT	6" BUTTERFLY VLV.	LOCATE LABEL PLATE ON VALVE LEVER, PLATE TO CONFORM TO CONTOUR OF LEVER.
V	2	II		B/B PMP STR DRN	½" GLOBE, VLV.	LOCATE LABEL ON HINGED PLATE ABOVE VALVE
W	2	II		B/B PMP STR VT	½"	LOCATE LABEL PLATE ON STRAINER COVER.
X	2	I		VAC PRIMING VALVE SHUTOFF	2" GATE	LOCATE LABEL ON PIPE, NEAR VALVE.
Y	2	I		VAC PRIMING SYS ISOLATION	1½" GLOBE	
Z	2	I		VAC PRIMING VALVE SHUTOFF	½"	MOUNT TO SUPPORT BRKT DET. 11-C (NOTE 4)
AA	2	I		VAC PRIMING VALVE SHUTOFF	½"	MOUNT TO SUPPORT BRKT. DET 11-C (NOTE 4)
AB	2	I		PUMP SUCT PRESS GAGE	½"	
AC	2	I		PUMP DISCH PRESS GAGE	½"	
AD	2	I		INBD BILGE/BAL PMP DISCHARGE	GAGE BOARD	MOUNT ON BOARD DIRECTLY UNDER GAGE
AE	2	I		INBD BILGE/BAL PMP SUCTION		
AF	2	I		OUTBD BILGE/BAL PMP DISCHARGE		
AG	2	I		OUTBD BILGE/BAL PMP SUCTION		
AH	1	I		PURIFIER RM FWD BILGE SUCT	2½" STOP CHECK VLV.	MOUNT TO SUPPORT BRKT. DET. 11-C (NOTE 4)
AJ	1	I		OILY WATER HOLDING TK SUCT	6" STOP CHECK VLV.	
AK	1	I		SNDG TUBE ENG RM VOID PORT FWD	1½" QUICK OPNG GATE VLV.	WIRE LABEL PLATE TO VALVE FOR SHIPMENT, FINAL LOCATION TO BE ON ADJACENT BHD.



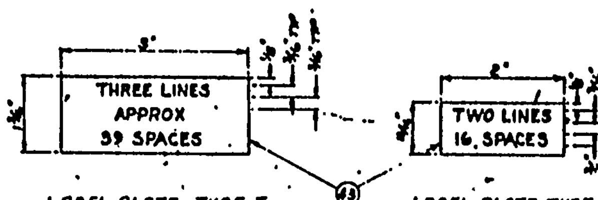
SUPPORT BRKT.
SEE NOTE 4
DETAIL 11-C



KEY PLAN-LABEL PLATE LOCATION
(NOT TO SCALE)

LABEL PLATE — NOTES

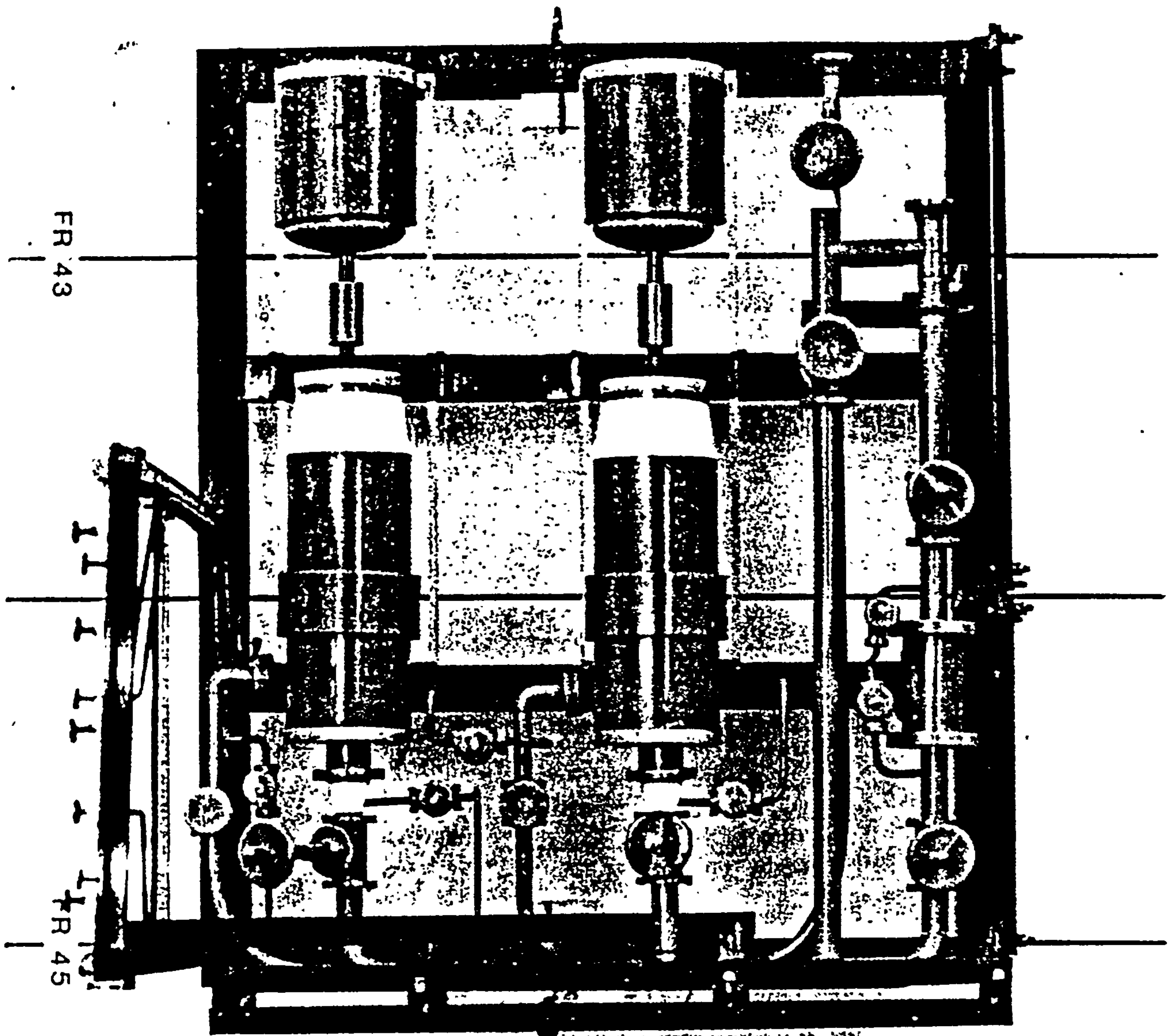
1) ALL LABEL PLATES (ITEM 43 IN PARTS LIST) SHOWN ON THIS DWG. ... MADE BY THE METAL-PHOTO PROCESS ON PHOTOSENSITIVE AND... 20 GA., CONFORMING TO MIL-P-15024, BLACK INSCRIPTION, GOTHIC ... ARABIC NUMERALS.
2) ALL LABEL PLATES SHALL BE LOCATED TO INSURE MAXIMUM VISIBILITY...
3) ABBREVIATIONS SHALL BE AS INDICATED IN LABEL PLATE LIST.
4) SUPPORT BRKT. DET. 11-C TO BE ATTACHED TO VALVE STEM, BONNET... FLANGE BOLT AS APPROPRIATE.
5) RECTANGULAR PLATES TO BE ATTACHED WITH PRESSURE SENSITIVE...
6) INSCRIPTION TO BE NEATLY CENTERED ON LABEL PLATE.



LABEL PLATE - TYPE I
FULL SIZE

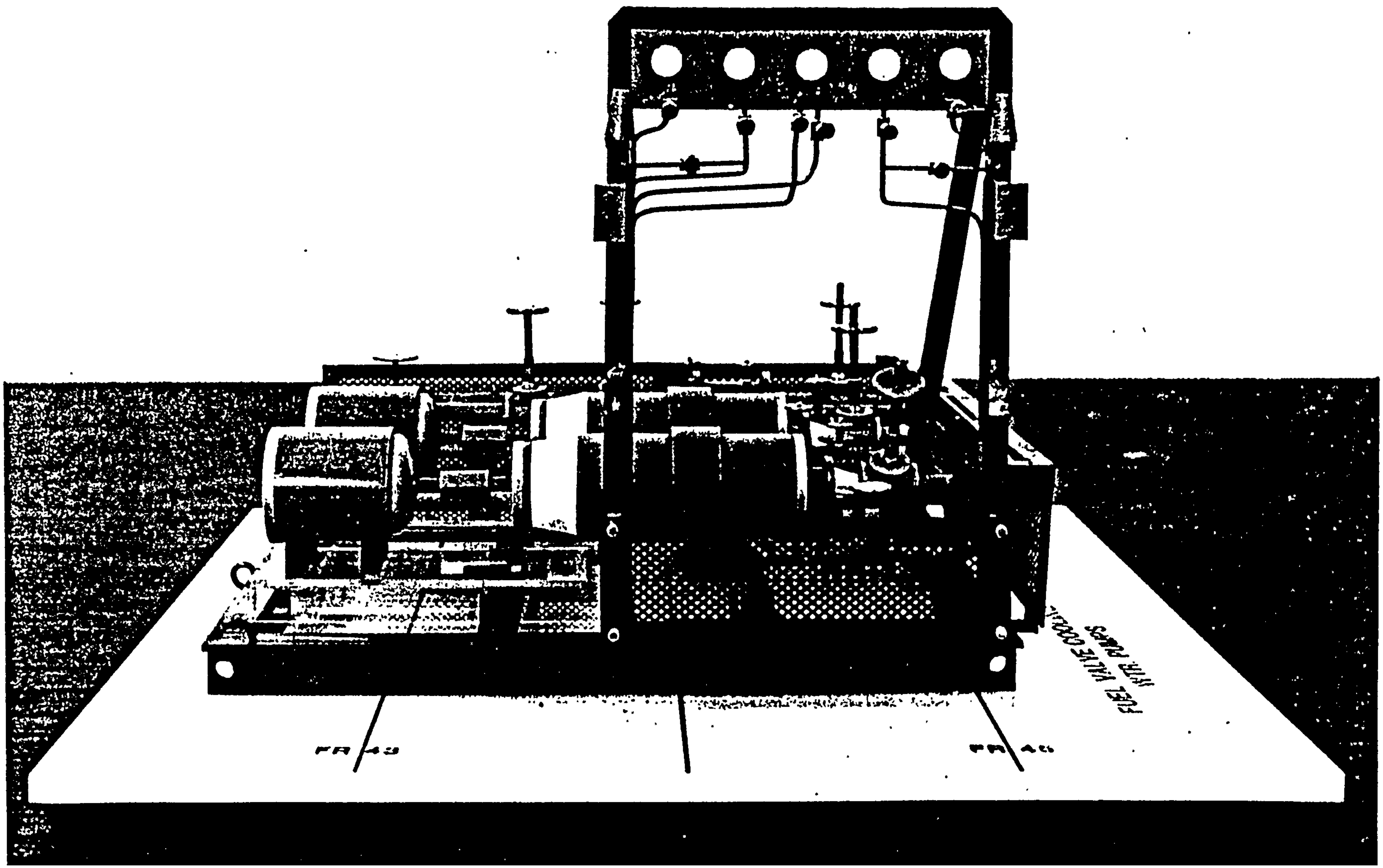
LABEL PLATE - TYPE II
FULL SIZE

D	C1-13	81-M18-...
		CONT. ON ...



FUEL VALVE COOLING
WTR. PUMPS

CI-015
81-M22-03X
1" to 1'



THIS DRAWING CONTAINS MATERIAL WITH THE FOLLOWING PALLET CODES

PALLET CODE	DESCRIPTION
S	DURING SUB ASSEMBLY ....ON UNIT
U	BEFORE TURNING DURING MN ASSY ....ON UNIT
T	AFTER TURNING — PRIOR TO PAINT ....ON UNIT
V	AFTER PAINT — PRIOR TO ERECTION ....ON UNIT
J	AFTER JOINING W/OTHER UNITS — PRIOR TO ERECTION..ON BLOCK
X	BEFORE CLOSING IN ....ON BOARD
Y	EASY ACCESS OR ON OPEN DECK ....ON BOARD
Z	FINAL OUTFITTING, PILFERABLES, SPARE PARTS, LOOSE ITEMS, ETC. ....ON BOARD
1R	MATERIAL TO BE ROUTED TO RACK ASSEMBLY AREA
1P	MATERIAL TO BE ROUTED TO PACKAGE UNIT SHOP
1	MATERIAL TO BE ROUTED TO PIPE SHOP
2	MATERIAL TO BE ROUTED TO FRP PIPE FABRICATION AREA

PH-45

THIS DRAWING FOR
ASI HULL 2335
SHIP B ONLY

JUN 25 1982

PH-46

REV	NO	TITLE	DRAWING NO
	3	MN. DK RACK PIPING STBD SIDE FR 70-73 PKG. UNIT HULL "B" ONLY	91-61B-016
	2	PAINT SCHED. ZONES A, D+M	19-01-01
	1	MN. DK RACK PIPING STBD. SIDE FR. 70-73 PACKAGE HULL "B" ONLY	91-61B-01Y

REFERENCES

RECORD INFO

ASI HULL NO	NAME OF VESSEL
~~2237~~	
~~2306~~	
2335	

AVONDALE SHIPYARDS INC
P O BOX 50280
NEW ORLEANS, LA
70150

A S I JOB NO **C1-15**

EXXON COMPANY, USA

42,000 DWT MULTI-PRODUCTS CARRIER
MN. DK. RACK PIPING
STBD. SIDE FR 70-73
PKG. UNIT HULL B
PIPE DETS.

DRAWN BY M. VIATOR DATE 10-22-81
CHECKED BY JJK DATE 10-25-81
APVD [signature] MECH. ENGINEER
APVD A Nierenberg 12/7/81 ASST CHIEF ENGINEER
APVD 12/9/81 R.B. Ekholm

SIZE A
ASI DWG NO C1-15 91-61B-017
SCALE

A-TB-E (1-81)

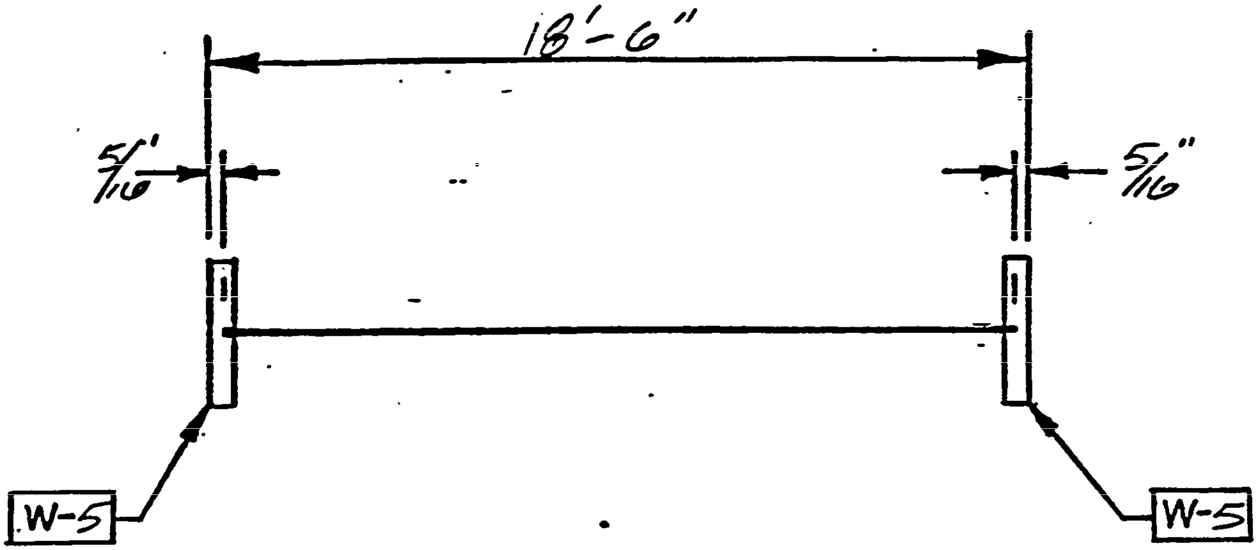
RAY ____
ICKLE AFT FAB ____
ALV AFT FAB X

CUT ____
BEND ____
BEND ____
FAB ____
NOTES ____

NO REQD 1
PALLET NO 06-61B-
COATING I ——
O ——

(2") C.L. = 221.3

PH-47



061409 - PIPE STL SMLS XS ASTM A 53 GR B
170709 - FLG'D STL SW 150 ASTM A105 GR I/II ANSI B16.5 XS BORE

COST CODE

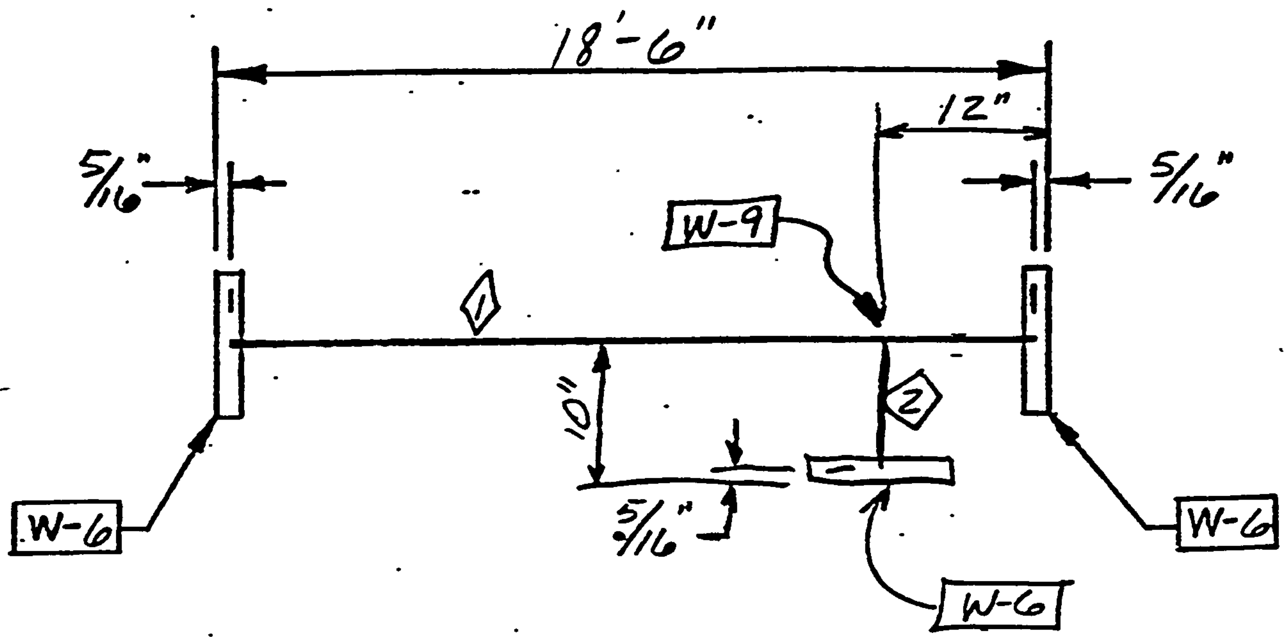
AVONDALE SHIPYARDS, INC
P O BOX 50280 NEW ORLEANS, LA 70150

TITLE: MN. DK. RACK PIPING STBD SIDE

JOB NO C1-00
DWG NO 91-61B
DWN [illegible]
REVISION

II X	PIPE SHOP USE ONLY		P D NO 27-4"
	CUT		NO REQD 1
	BEND		PALLET NO 06-618-0
E AFT FAB X	BEND		COATING I OIL
AFT FAB	FAB		O 3,7,3
	NOTES		

(4") C.L.1 = 221,37
(4") C.L.2 = 13"



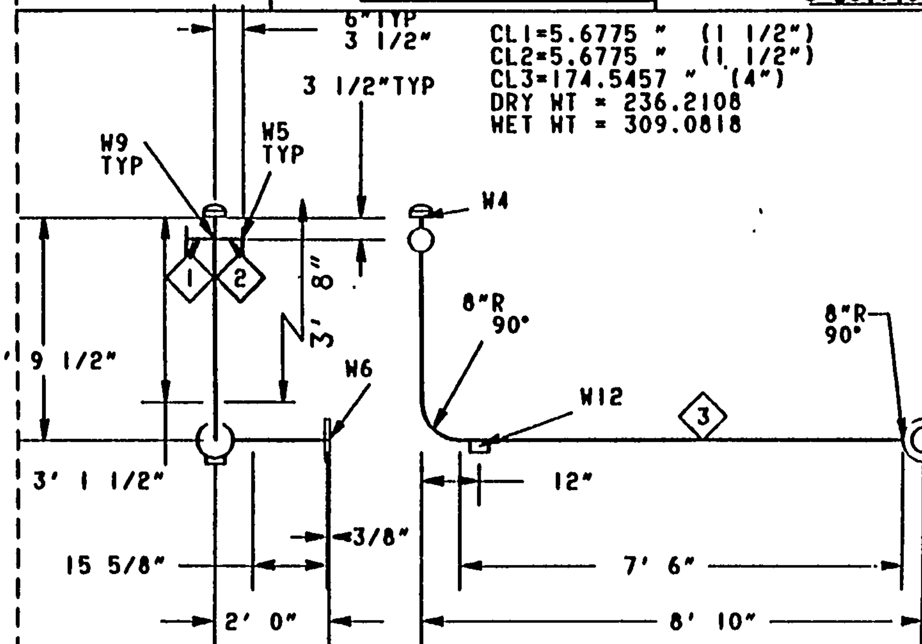
3/3- PIPE STL SMLS STD ASTM A53 GRB
3- FLG'D STL SLIP-ON 150 ASTM A105 GR 1/II ANSI B16.5 RF

AVONDALE SHIPYARDS, INC P O BOX 50280 NEW ORLEANS, LA 70150	JOB NO C1-001
	DWG NO 91-618-
TITLE MN DK ...	DWN

PIPE SHOP ROUTING

DESCRIPTION	WORK STATION PLANNED	NEXT
00061413		
00062208		
CLEAN EXTERNAL	2.1	2.2
CLEAN INTERNAL	2.2	17.8
00062208		
STONE SAW - 3"	17.8	4.1
00061413		
SAW CUT 2"-14"	4.1	11.1
CL3		
4" BENDER (CONRAC)	11.1	9.5
00070113		
00074608		
00127604		
00130213		
CL1,CL2		
SUB ASSEMBLY	9.5	18.2
GALVANIZING	18.2	13.1
PALLETIZING	13.1	14.1
STORAGE	14.1	

CLASS I II XX	PIPE SHOP USE ONLY	P.D.NO. 14-4"
N D T	CUT	NO.REQD. 1
PICK AFT FAB	BEND	PALLET NO 06-61B-1R
GALV AFT FAB XX	BEND	COATING 1
	FAB	0 20,7,34
	NOTES	



00061413		PIPE STL SMLS SCH 80 (XS) ASTM A53 GR B 4"
00062208		PIPE STL SMLS SCH 80 (XS) ASTM A106 GR A & B 1 1/2"
00070113	1	FLANGE STL SLIP-ON 150 ASTM A105 ANSI B16.5 RF 4"
00074608	2	FLANGE STL SOCKET WELD 150 ASTM A105 ANSI B16.5 XS BORE FF 1 1/2"
00127604	1	COUPLET STL FORGED SW 3000 ASTM A105 VOGT SW 1211 1/2"
00130213	1	CAP STL BW XH ASTM A234 ANSI B16.9 4"

COST 0603	AVONDALE SHIPYARDS, INC. P.O. BOX 50280 NEW ORLEANS, LA. 70150	JOB NO. C1-15
	TITLE: MN.DK.RACK PIPING STBD SIDE FR 70-73 PACKAGE UNIT HULL "B" ONLY	DWG NO. 91-61B-01
		DWN T.Y.N.
		REVISION 1

SHEET 18

PIPE SHOP ROUTING

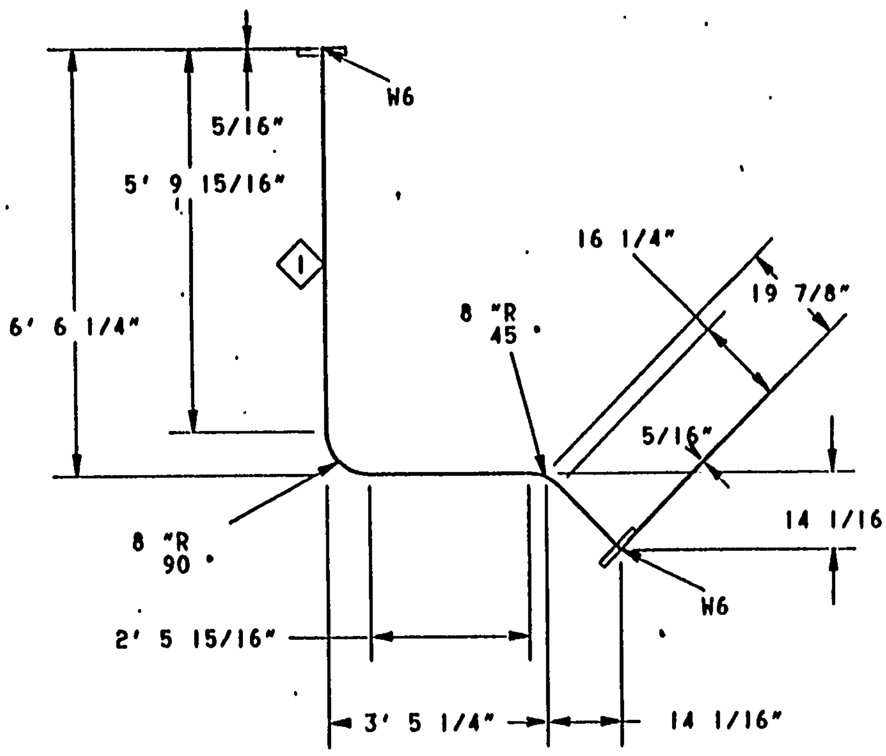
DESCRIPTION	WORK STATION PLANNED	NEXT
00061313		
CLEAN EXTERNAL	2.1	2.2
CLEAN INTERNAL	2.2	3.1
PAINT EXTERNAL	3.1	4.1
SAW CUT 2"-14"	4.1	5.2
PIPE END CLEANER	5.2	8.2
CLI		
00070113		
FLG WELD (SO) 1 1/2"-12"	8.2	11.1
4" BENDER (CONRAC)	11.1	9.5
SUB ASSEMBLY	9.5	13.1
PALLETIZING	13.1	14.1
STORAGE	14.1	16.1
PACKAGE UNIT ASSEMBLY	16.1	

CLASS I IIXX
X-RAY
PICK AFT FAB XX
GALV AFT FAB

PIPE SHOP USE ONLY
CUT
BEND
BEND
FAB
NOTES

P.D.NO. 13-4"
NO.REQD. 1
PALLET NO 06-618-01R
COATING I 220R61 / 0 3,7,34

4"-CL1=135"



00061313 PIPE STL SMLS STD ASTM A 53 GR B 4"
00070113 2 FLANGE STL SLIP-ON 150 ASTM A105 GR I/II ANSI B16.5 RF 4"

COST CODE	AVONDALE SHIPYARDS, INC. P.O. BOX 50280 NEW ORLEANS, LA. 70150	JOB NO. C1-15
0609	TITLE: MN. DK. RACK PIPING STBD SIDE FR 70-73 PACKAGE UNIT P/D HULL "B"ONLY	DWG NO. 91-618-017 DWN TYN REVISION 1

SHEET 17

PH-50

PIPE SHOP ROUTING

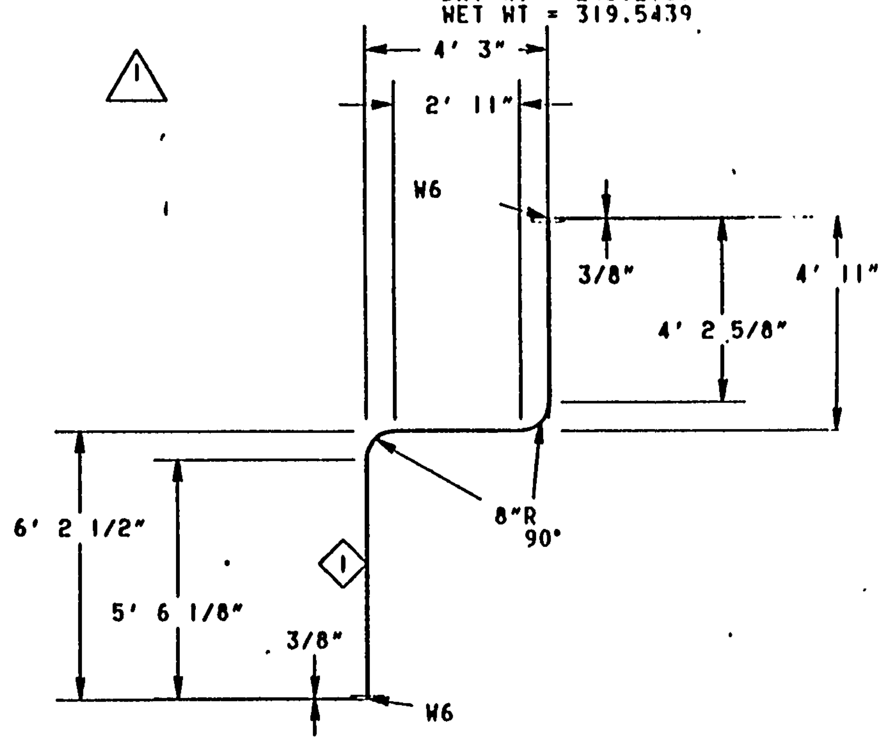
DESCRIPTION	WORK STATION PLANNED/NEXT	
00061413		
CLEAN EXTERNAL	2.1	2.2
CLEAN INTERNAL	2.2	4.1
SAW CUT 2"-14"	4.1	8.2
CL1		
00070113		
FLG WELD (SO) 1 1/2"-12"	8.2	11.1
4" BENDER (CONRAC)	11.1	9.5
SUB ASSEMBLY	9.5	18.2
GALVANIZING	18.2	13.1
PALLETIZING	13.1	14.1
STORAGE	14.1	

CLASS I ___ II XX
N D T ___
PICK AFT FAB ___
GALV AFT FAB XX

PIPE SHOP USE ONLY
CUT
BEND
BEND
FAB
NOTES

P.D.NO. 15-4"
NO.REQD. 1
PALLET NO 06-61B-01R
COATING I
0 20.7.34

CL1=176.8337 " (4")
DRY WT = 245.2738
WET WT = 319.5439



00061413 PIPE STL SMLS SCH 80 (XS) ASTM A53 GR B 4"
00070113 2 FLANGE STL SLIP-ON 150 ASTM A105 ANSI B1 6.5 RF 4"

COST	AVONDALE SHIPYARDS, INC. P.O. BOX 50280 NEW ORLEANS, LA. 70150	JOB NO. C1-15
0603	TITLE: MN.DK.RACK PIPING STBD SIDE FR 70-73 PACKAGE UNIT HULL "B" ONLY	DWG NO. 91-618-017 DWN T.Y.N. REVISION 1

SHEET 19

BIP

REV	NO	TITLE	DRAWING NO
	3	PIPING MAT'L SCHEDULE	06-00-10
	2	BOLT NUTS & GASKET STD FOR PIPE FLANGED JOINT (THRU 300)	MECH STD NO. 37
	1	MN. DK. RACK PIPING STBD. SIDE FR. 70-73 PACKAGE UNIT - HULL "B" ONLY	91-61B-016

REFERENCES

RECORD INFO

THIS DRAWING FOR ASI HULL 2335 SHIP B ONLY

JUN 25 1982

ASI HULL NO	NAME OF VESSEL
~~2337~~	
~~2336~~	
2335	

AVONDALE SHIPYARDS INC
P O BOX 50280
NEW ORLEANS, LA
70150

A S I JOB NO **C1-15**

EXXON COMPANY, USA

DRAWN BY RSP DATE 11-2-81

CHECKED BY EVC DATE

APVD MECH ENGINEER

APVD [signature] 12-7-81 ASST CHIEF ENGINEER

APVD R. B. Ekholm 12/9/81

42,000 DWT MULTI-PRODUCTS CARRIER

MN. DK. RACK PIPING STBD. SIDE
FR. 70-73 PACKAGE UNIT L/M

SIZE A

ASI DWG NO C1-15 91-61B-016

SCALE

SHEET

6/11/82

LIST OF MATERIAL QUANTITY (1) SHIP REQ.NO.

. MK.	QTY	DESCRIPTION	UNIT PRICE	T P
0017034	2	VALVE HOSE ANGLE BRZ FLG 150# MONEL STEM W/MOLDED COMPOSITION W/BRZ DISC HOLDER FURNISHED W/BRZ SLOTTED CAP & CHAIN 1 1/2 9NH APPLIES TO HULL 1 ONLY ***** PALLET CODE FOR THIS ITEM = 0603 901 1R	PH-53	
0040225		VALVE GATE STN STL TY 316 FLG 150 STN STL TRIM UNION BONNET + 3/4		
		SUB-ALLOCATION GROUP QTY/SHIP PALLET CODE NO. VES HULL NO(S) 1 2 0602 901 1 1 1 ONLY 2 2 0611 901 1 1 1 ONLY		
0056027	5	VALVE BALL STN STL 316 BODY SW END CONN 316L W/TEFLON SEAT & SEAL FIRE SAFE MARPAC TRI-PAC SS-B325-TT P-NS2 - 1 1/2 APPLIES TO HULL 1 ONLY ***** PALLET CODE FOR THIS ITEM = 0602 901 1R		
0060826	21'	PIPE STL SMLS SCH 80 ASTM A 53 GR B 16 APPLIES TO HULL 1 ONLY ***** PALLET CODE FOR THIS ITEM = 0602 901 1		
0061311	38'	PIPE STL SMLS SCH 40 (STD) ASTM A 53 GR B 3 APPLIES TO HULL 1 ONLY ***** PALLET CODE FOR THIS ITEM = 0611 901 1		

.	AVONDALE SHIPYARDS,INC. P.O. BOX 50280 NEW ORLEANS,LA.70150	CUSTOMER EXXON INT CO
D.	TITLE MN.DK. RACK PIPING STBD. SIDE FR.70-73 PACKAGE UNIT L/M	JOB NO. C1-0015 DWG.NO 91 61B 016

6/17/82 P.O.NO

LIST OF MATERIAL QUANTITY (1) SHIP REQ.NO

C. MK.	QTY	DESCRIPTION	UNIT PRICE
00061313		PIPE STL SMLS SCH 40 (STD) ASTM A 53 GR B 4 SUB-ALLOCATION NO. GROUP QTY/SHIP PALLET CODE VES HULL NO(S) 1 83 0602 1 1 1 ONLY 2 20 0611 1 1 1 ONLY	
00061315		PIPE STL SMLS SCH 40 (STD) ASTM A 53 GR B 6 SUB-ALLOCATION NO. GROUP QTY/SHIP PALLET CODE VES HULL NO(S) 1 7 0602 901 1 1 1 ONLY 2 90 0611 901 1 1 1 ONLY	
00061316	40'	PIPE STL SMLS SCH 40 (STD) ASTM A 53 GR B 8 APPLIES TO HULL 1 ONLY ***** PALLET CODE FOR THIS ITEM = 0602 901 1	
00061317	96'	PIPE STL SMLS SCH 40 (STD) ASTM A 53 GR B 10 APPLIES TO HULL 1 ONLY ***** PALLET CODE FOR THIS ITEM = 0609 901 1	
00061409		PIPE STL SMLS SCH 80 (XS) ASTM A53 GR B 2 SUB-ALLOCATION NO. GROUP QTY/SHIP PALLET CODE VES HULL NO(S) 1 20 0602 1 1 1 ONLY 2 30 0611 1 1 1 ONLY	

.	AVONDALE SHIPYARDS,INC. P.O. BOX 50280 NEW ORLEANS,LA.70150	CUSTOMER EXXON INT
D.	TITLE MN.DK. RACK PIPING STBD. SIDE FR.70-73 PACKAGE UNIT L/M	JOB NO. C1-0015 DWG.NO 91 618 016

DESIGN ENGINEERING FOR ZONE OUTFITTING
ACONDALE SHIPYARDS, INC.

OUTFITTING SECTION

DESIGN ENGINEERING FOR ZONE OUTFITTING
OUTFITTING SECTION

I. INTRODUCTION

Avondale Engineering's response to zone outfitting at Avondale has been geared toward production needs, especially in the areas of Hull Structure, Piping/Machinery and Material Control. In order to support this effort and to keep ourselves current with the changing work procedures, the Outfitting Engineering Section has attempted to respond to the needs that we have seen created by the implementation of zone outfitting technology.

We saw the need to respond in two main areas:

To provide engineering information in an early enough time frame to support the timely development of work in all other engineering sections.

To respond to the Production Department needs created by zone outfitting.

II. OUTFITTING RESPONSE TO ENGINEERING SECTIONS' "NEEDS" (SHOW GRAPH NO. OF-1)

Because any lack of Outfitting Section responsible information required by other engineering sections is a potential cause of schedule slippage, these items must be addressed early on, even in the pre-contract stage, if possible. In addition, new U.S. Coast Guard regulations require submittal of drawings such as hazardous area. definitions, fire control information, and bulkhead and deck classifications "up front," right at the beginning of the contract.

As a result, this information must be scheduled for development as early as possible.

To support zone outfitting, the Outfitting Section must have an early start to provide the following information:

access information

compartmentation defilement

equipment system definition

Originally, this "catalog" existed for only piping materials, but now AS I is proceeding with the development of such a catalog for all raw materials and the Outfitting Section is handlinG the catalog development for all outfitting materials. We are alsO adding-the material catalog numbers to our drawings in anticipation of the implementation of this computer system.

B) MATERIAL FABRICATION

Another development which has been incorporated into the drawings is the isolation of the fabrication information so that only the information required to fabricate a given sub-assembly is shown.

Once the raw material is fabricated into finished items, then the various raw material piece numbers can no longer be used to track the material; therefore, a new identifier must be assigned. This new identifier is called a "Sub-Assembly No." For example, VL = Vertical Ladder, IL = Inclined Ladder, etc.

After having gone almost completely through the Exxon contract and using the sub-assembly numbers throughout, our list of sub-assembly numbers is still less than 100. What this implies is that the fabricated items which the Outfitting Section supplies can be described or identified by less than 100 components.

Using the sub-assembly numbers as a heading, the Production Department has the capability of "loading" into the computerized material control system all the raw material required to fabricate a given sub-assembly. Outfitting has added this concept of sub-assembly numbers to all drawings for the Exxon contract in anticipation of the computer system implementation.

We are now in the process of converting some of the more commonly used "sub-assembly" components into yard standards which will eliminate the need to draw the same sub-assemblies over and over again.

We have broken down the material lists so that the material for each sub-assembly is separate from the next sub-assembly to facilitate easy entry into a computer data base. Painting information is shown for each sub-assembly in the same area as the details for the fabrication.

The concept of a "sub-assembly" as a pre-fabricated outfitting component becomes important at this stage.

Previously, we mentioned that the Outfitting Section had endeavored to isolate fabrication information from installation information. The reason for this will become obvious when we consider that if a given sub-assembly comes to the installation site in a finished or pre-fabricated state, then the person doing the installation has no need for any of the fabrication information. He only needs to know where it goes and how it is installed.

Sometimes if the sub-assembly is a simple one, the two types of information may be combined, but only when the drawing does not become too complicated.

Often times the designer may build into the sub-assembly some feature such as a slip joint to make the job of installation easier. He may ask for locating "shop marks" as part of the fabrication process. These special features are then noted on the installation part of the drawing.

The two-digit sub-assembly numbering system is also a help to the installers in that over a period of time they will develop a sort of jargon which will convey much more information than previously. For example: "Get me one VL-10 and a PT-6 right away, tells the man immediately that the subjects of the conversation are a 10'-0"vertical ladder and type 6 platform. If he had said, "Get me one Detail 6-A and a Detail 16B-1," there would have been no communication.

The Outfitting Section is developing arrangement drawings which show the installation of the sub-assemblies using the sub-assembly numbers only. The location dimensions on these drawings are to the nearest structure or to a datum line so as to insure that the installer has a "real" place to measure from, because often times the unit is not assembled into the hull form and the conventional datum lines may not be on the unit at all.

With much more material being added to the units before they are assembled one to another, the weight of the added outfitting material becomes an important factor in unit handling. The weight is also a good indication of the percent complete of the ship. For example, if we know that there are 100 tons of outfitting material assigned to a given unit or package and only 75 tons have been installed, then we say that the job is 75% complete.

2) The affected areas of the ship have been added to the title block so that anyone reading the title will know what areas are covered by the drawing.

B) <u>INDEX SHEET</u> (SHOW GRAPH NO. OF-5)

The arrangement of the sheets within the drawing has been made so that all of the fabrication information for a given sub-assembly may be removed from the drawing and will stand alone (inclined ladder, fab details and vertical ladder fab details), and all of the information required to install the sub-assembly can likewise be removed and will stand alone.

Also, note that the fabrication information for one sub-assembly is separate from the fabrication information for the next sub-assembly.

The order of presentation is as follows: First comes parts list (purchasing data), then key plans, fabrication information, and finally installation data. This order was chosen because it closely follows the actual sequence of operations at ASI.

C) <u>GENERAL NOTES</u> (SHoW GRAPH NO. OF-6)

In addition to the usual General Notes, there has been added an explanation of the various sub-assembly numbers used in the drawing to insure that they are understood.

Also added to the General Notes is an explanation of how the sub-assembly information is shown in the key plans. This system of conveying information has been developed because it is a simple way to inform the reader exactly where to go to find out how to fabricate or how to install the given sub-assembly.

D) <u>TOTAL PARTS LIST (MATERIAL LIST)</u> (SHOW GRAPH NO. OF-7)

This sheet serves as a purchasing document for the total amount of raw material required to fabricate everything on the drawing. The additions made to this sheet are the two columns marked "unit weight" and "ASI Std. Part No.”"

The unit weight column allows the weight group to calculate the weight of the added outfitting material for a given unit for purposes of unit lifting and handling. The ASI Std. Part No. allows the Material Control Group to enter the raw material into a computer data base where many different kinds of operations may be performed on it.

H) <u>SUB-ASSEMBLY FABRICATION DETAIL SHEETS</u> (SHOW GRAPH NO. OF-11)

The details for the actual fabrication of a sub-assembly are given in pre-engineered detail sheets which are photographed and inserted into the drawinG. Note the "A" and "B" dimen- -sions which are supplied by the detail tabulation sheets.

It is these pre-engineered sheets which are prime candidates for a program of standardization.

I) <u>LOCATION TABULATION SHEETS</u> (SHOW GRAPH NO. OF- *12)*

Once we begin to talk about location information, then, our interest swings from fabrication to installation.

It is the location tabulation sheet which provides the installer with the exact information he needs in order to install a given sub-assembly. It is here where we find such items as datum lines for "real" location points and a column for special installation details which may be required.

It is on this sheet, also, that we find the pallet code or "address" for each sub-assembly.

Note that because the "address" may be different for each sub-assembly, though the sub-assembly may be exactly like others and have the same sub-assembly number, it must be listed on its own line in the location tabulation sheet.

J) <u>INSTALLATION DETAIL SHEETS</u> (SHOW GRAPH NO. OF- 13)

These sheets contain details which show special problems relating to the installation of the sub-assembly or else show the orientation aboard the ship. They serve as a visual aid to the installer and as an extension of the location tabulation sheet.

VI. <u>EFFECT ON TIME FRAME, BUDGET AND PERSONNEL</u>

A) <u>TIME FRAME</u>

The need for more information "up front" has caused the Out- fitting Section more work at the beginning of the contract, sometimes even at the pre-contract stage of the job, than has been done previously. This means that more time and personnel have to be made available at a time when they may be needed to finish up on another contract.

VI 1. FUTURE DEVELOPMENTS (SHOW GRAPH NO. OF- 14)

Increased use of computer technology, development of yard standards, use of pre-engineered detail sheets and/or computer drafting, and valuable input from Production feedback, as well as improvements made by our own personnel in the section, should combine to reduce the increase in manhours considerably in the future.

We look forward to the start of our next job and the opportunity to show just how much we have learned from initial applications. We believe that we have made some tremendous progress, but that there is still more progress to come as we further refine the system.

ENGINEERING SECTION "NEEDS OR REQUIREMENTS"

- EARLY ACCESS INFORMATION
- EARLY COMPARTMENTATION DEFINITION
- EQUIPMENT SYSTEM DEFINITION
- PAINT INFORMATION
- IDENTIFICATION AND LOCATION OF JOINER SYSTEMS
- EARLY VENDOR IDENTIFICATION
- CLASSIFICATION OF DECKS & BULKHEADS
- INSULATION REQUIREMENTS
- HAZARDOUS AREA DEFINITIONS
- WEIGHT INFORMATION

OUTFITTING "RESPONSE" TO PRODUCTION "NEEDS"

PRODUCTION "NEEDS"

MATERIAL CONTROL	MATERIAL FABRICATION	MATERIAL ROUTING	MATERIAL INSTALLATION
• RAW MATERIAL CATALOGUE • AUTOMATED MATERIAL CONTROL SYSTEM	• SUB ASSY. NO'S. • YARD STANDARDS • PHOTO DRAFTING • SUB ASSY. PARTS LIST • SEPARATE FAB. DETS.	• PALLET CODES • UNIT DIVISIONS IN LARGE DRAWINGS	• SUB ASSY. NO'S. • SEPARATE INSTALLATION DETAILS • "REAL" LOCATING DIMS. • WEIGHT INFO.

OUTFITTING "RESPONSE"

IMPLEMENTATION OF I.H.I. SYSTEM BY PRODUCTION GENERATES AN ENGINEERING RESPONSE

OF-3

DISTRIBUTION

DEPARTMENT	NUMBER	REVISION
PRODUCTION	4	
PROD PLANNING	3	
MOLD LOFT	4	
PLANT ENGR & MAINT		
ESTIMATING		
PROGRAM MANAGER	1	
QUALITY CONTROL		
ELECTRICAL	1	
STANDARDS		
FILES & RECORDS	1	
HULL		
HULL COMPOSITE		
DESIGN	1	
OUTFITTING	2	
STL TAKE OFF		
H V A C		
MATERIAL REQMT		
MECHANICAL	2	
MECH COMPOSITE	2	
ENGR PLAN & SCHED		
BAYOU BLACK		
HARVEY		
SERVICE FOUNDRY		
JOINER CONTRACTOR		
ADMEASURER		
MARAD (WASH)		
MARAD (YARD)		
OWNER (HOME)	3	
OWNER (YARD)	1	
ABS (NY)		
ABS (NO)		
ABS (YARD)	1	
USCG (NO)	2	
USCG (YARD)		
USPHS		
OWNER - [illegible]	2	
TOTAL	30	
PARTIAL ISSUE		
DATE OF ISSUE		

PURCHASING

FABRICATION

FABRICATION

INSTALLATION

INDEX

SH NO	TITLE
1	TITLE BLOCK & REFERENCES
2	DISTRIBUTION & INDEX
3	GENERAL NOTES
4	REVISIONS
5	PARTS LIST (QUANTITIES FOR ONE VESSEL)
6 &6A	SUB-ASSEMBLY PARTS LIST - INCL. LDRS., VERT. LDRS. & DUST PAN
7 &7B	KEY PLANS
8	INCLINED LADDERS DETAIL TABULATION
9&9A	INCLINED LADDERS & DUST PAN FABRICATION DETAILS
10-10A	INCLINED LADDERS CLIP DETAILS
11	VERTICAL LADDERS DETAIL TABULATION
12	VERTICAL LADDERS FABRICATION DETAILS
13-13A	VERTICAL LADDERS CLIP DETAILS
14	INCLINED LADDERS LOCATION TABULATION
15-15B	INCLINED LADDERS ARRANGEMENT & INSTALLATION DETAILS
16	VERTICAL LADDERS LOCATION TABULATION
17-17C	VERTICAL LADDERS ARRANGEMENT & INSTALLATION DETAILS

O-F-5

SIZE	REVISION	ASI DWG NO	
C		C1-15	16-04-04

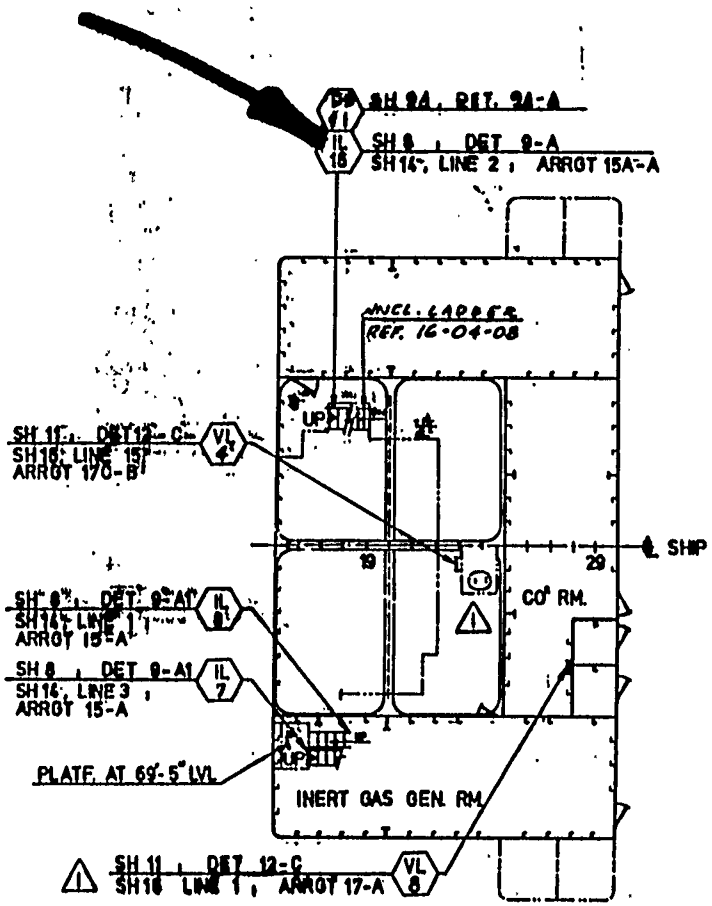
SH NO 2

MATERIAL LIST (QUANTITIES FOR ONE SHIP)

ITEM No	QUANTITY	DESCRIPTION	MATERIAL	SPEC ORD DATA	UNIT WEIGHT	ASI STD PT No	REMARKS
1	27	TREADS 9"×24" (1 1/2" NOSE/NO RISER)	STEEL	ASTM A-36	8.7 PER SQ.FT.	N/A	RAISED PATTERN FLOOR PLATE RYERSON OR EQ.
2	3	HANDGRAB - BAR 5/8" DIA / STD. HL-1	↓	↓	1.043 PER L/F	N/A	ASI STD DWG MS-16-HL-1 (TYPE 3)
3	66	BOLT, HEX HD 3/4"-10UNC-2A 2 1/4" LG	STN STEEL	TYPE 316	0.3706 PER ONE	LATER	
4	82	LOCKWASHER 3/4" SPRING (MED)	↓	↓	0.0676 PER ONE	10100-52-83	FOR PC NO. 3 & 14
5	82	NUT, HEX 3/4"-10UNC-2B	↓	↓	0.1876 PER ONE	10100-60-10	FOR PC. NO. 3 & 14
6	42 L/F	ANGLE 2 1/2" X 2 1/2" X 1/4"	STEEL	ASTM A-36	4.1# PER L/F	2-A36-519	
7	7.25 L/F	FLAT BAR 3" X 3/8"			3.83 PER L/F	2-A36-940	
8	851.5 L/F	FLAT BAR 2 1/2" X 1/2"			4.25# PER L/F	2-A36-935	
9	0.5 L/F	FLAT BAR 2 1/2" X 1/4"			2.13# PER L/F	2-A36-932	
10	161 L/F	SQUARE BAR 3/4" TO CUT 17 1/2" LG.			1.91 # PER L/F	2-A36-905	109 @ 17 1/2" LG.
11	84 L/F	CHANNEL, C6 X 10.5		↓	10.5# PER L/F	2-A36-1408	
12	154' L/F	PIPE, 1 1/4" STD		ASTM A-53	2.27# PER L/F	000060107	
13	15	TREADS 9"×18" (1 1/2" NOSE/NO RISER)	↓	ASTM A-36	8.7 PER SQ.FT.	N/A	RAISED PATTERN FLOOR PLATE RYERSON OR EQ.
14	16	BOLT, HEX HD 3/4"-10 UNC-2A 2" LG	STN STL	TYPE 316	0.3377 PER ONE	10100-52-69	
15	48 SQ.FT.	SHEET METAL, 16 GA.	STL. GALVANIZED	COM'L	2.5 PER SQ.FT.	LATER	1 PLATE AT 14'-9"×8'-10" CUT & KNUCKLE TO SUIT
16	18	BOLT HEX. HD., 1/4" DIA - 20 UNC 2A × 1" LG.		ASTM A-307 GR-B	0.17 PER ONE	10101200	
17	18	NUT HEX., 1/4" - 20 UNC 2B		↓	0.07 PER ONE	LATER	FOR PC. No. 16
18	18	LOCKWASHER, 1/4" DIA (SPRING TYPE MED.)		ASTM A-36	0.04 PER ONE		
19	18	BEVELED WASHER, 1/4" DIA	↓	ASTM A-307 GR-B	0.004 PER ONE	↓	↓

OF-7

MATERIAL LIST

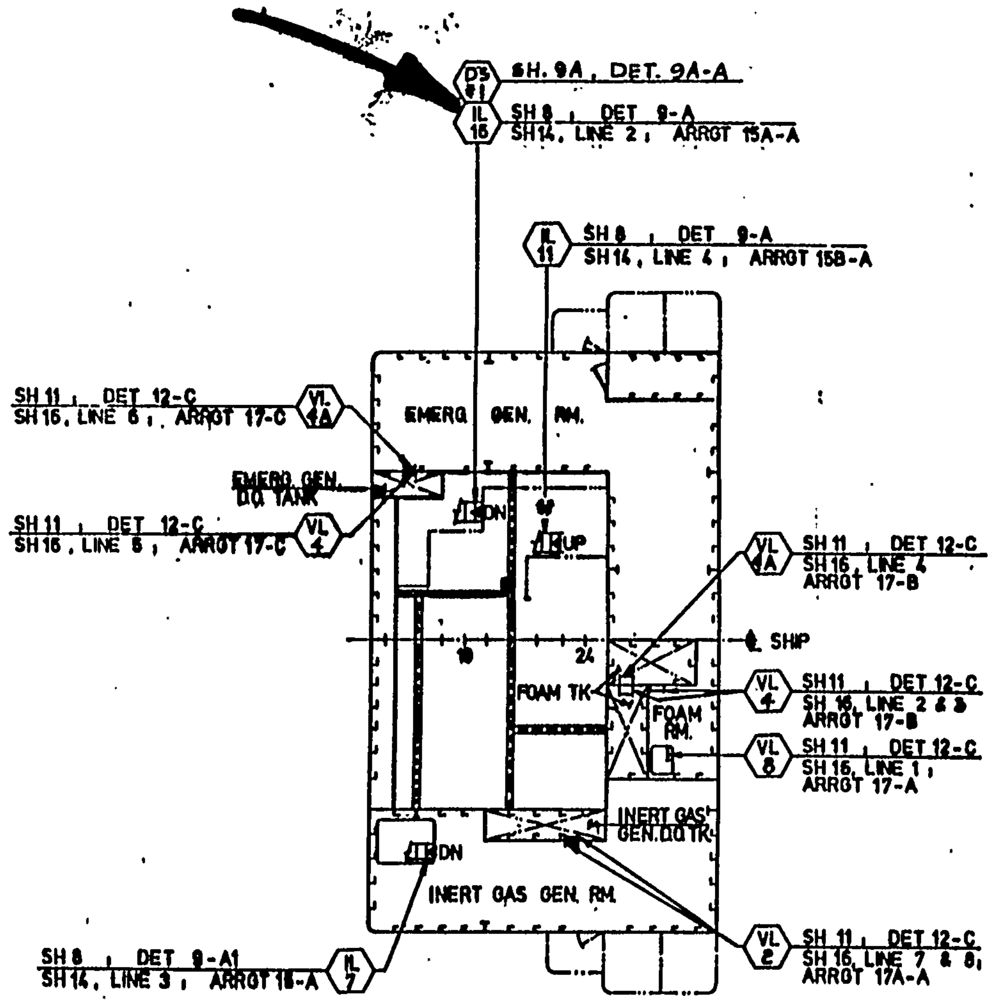


KEY PLAN 7-A

INSIDE & OUTSIDE MACHY CASING FR. 15-30

62'-0" ABL

NTS



KEY PLAN 7-B

INSIDE & OUTSIDE MACHY CASING FR15-30

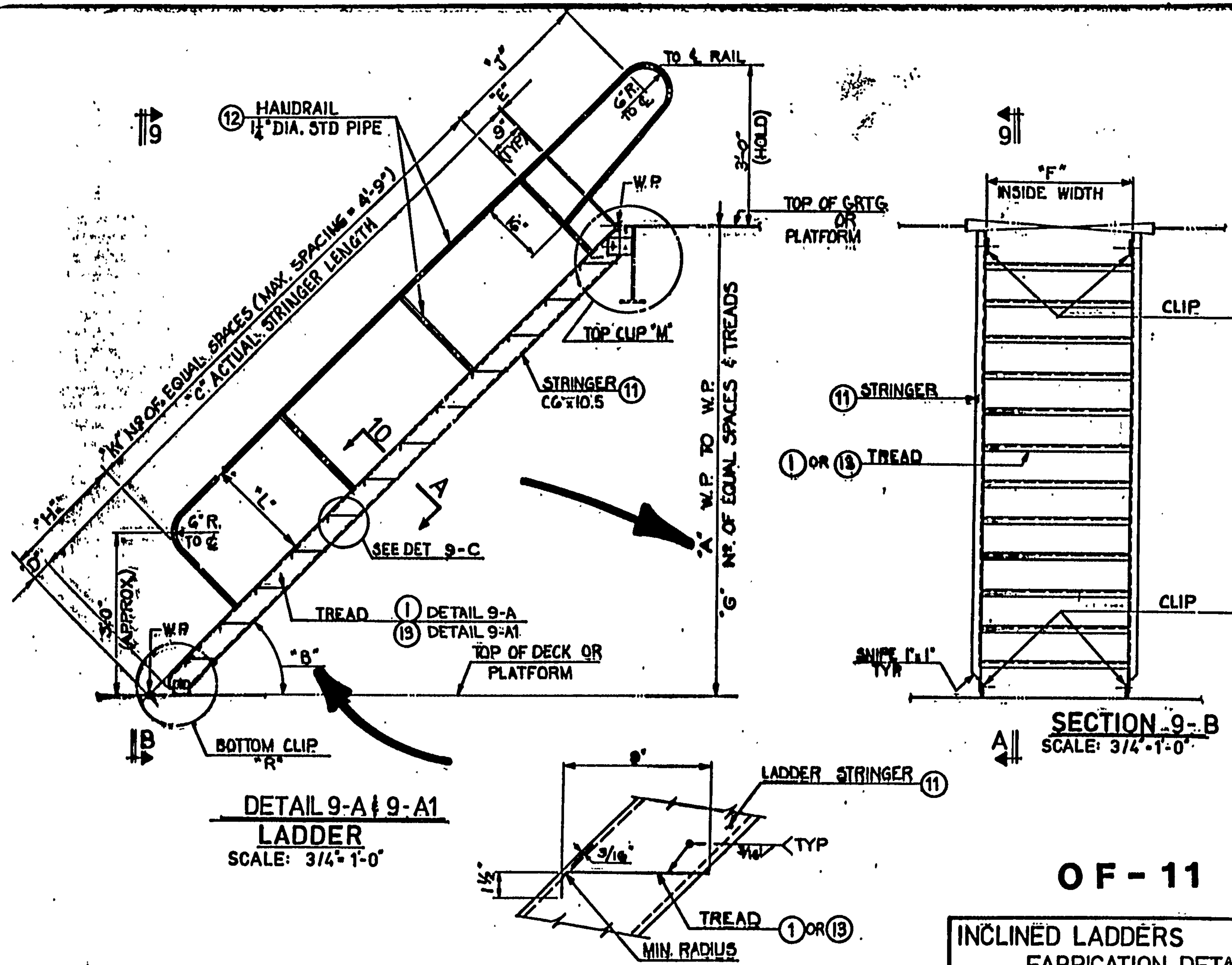
75'-6" LVL

NTS

OF-9

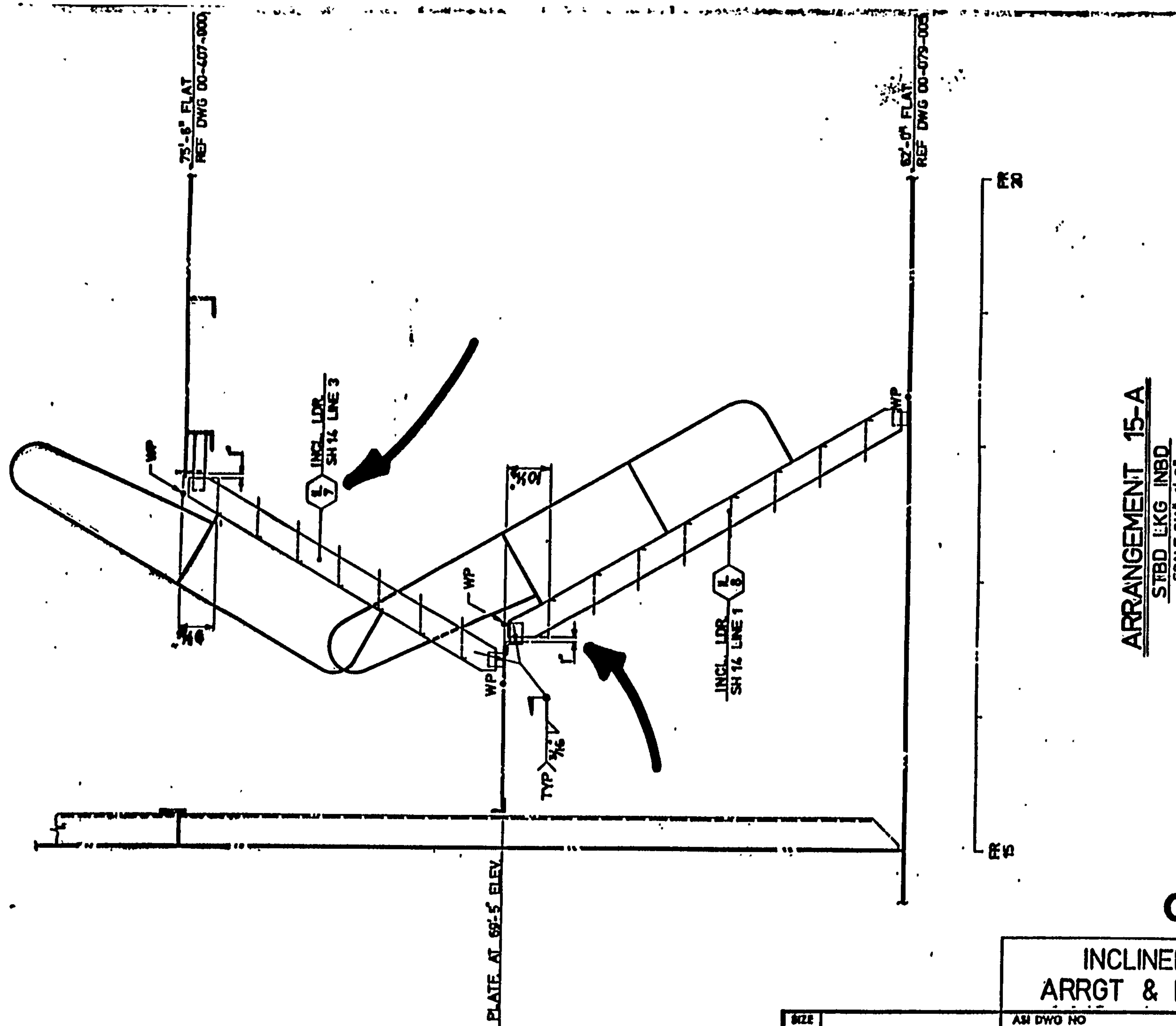
KEY PLANS

SIZE	REVISION	ASI DWG NO	
C		C1-15	16-04-04



OF - 11

INCLINED LADDERS
FABRICATION DETAILS



OF - 13

SIZE C	REVISION	INCLINED LADDERS ARRGT & INSTL DETS
		ASI DWG NO C1-15 16-04-04
		SH NO 15

DESIGN ENGINEERING FOR ZONE OUTFITTING
AVONDALE SHIPYARDS, INC.

ELECTRICAL SECTION

DESIGN ENGINEERING FOR ZONE OUTFITTING
ELECTRICAL SECTION

1. INTRODUCTION

Of the design engineering disciplines affected by zone outfitting, Electrical Engineering most certainly qualifies as one of the least affected. The impact on the electrical engineering implementation of zone outfitting to a particular job is primarily centered in changes to the design of the wireways and drawing format changes in the list of materials for deck plans and isometric wiring diagrams.

Due to the nature of electrical installation, most of the equipment and cabling are installed during the "on board" phase of zone outfitting, For most equipment, this is necessary to insure that the electrical components are not subject to adverse environmental factors such as weather, sandblasting, dust and paint spray, during the early stages of zone outfitting. Additionally, the unwanted exposure of electrical equipment to these elements could weaken the shipyard's position in claims negotiations with vendors concerning liability for subsequent warranty deficiencies. Electrical equipment installed "on unit" tends to be concentrated on vendor applied module packages and shipyard-built machinery package units.

Long runs of cable through the ship are installed in the traditional manner of pulling the cable from one endpoint to the other. Connection of the cables can then be handled by a hook-up crew at a later date. An alternate method of installing some of the multiconductor runs would be to prewire each unit to its own central junction box and then connect these junction boxes via jumper cables once the units are joined together. At present, this method is not used at ASI due to our determination that the resultant large increase in connection time, checkout time, and increased electrical system complexity would not represent a real savings in the cost of the final product to the shipyard. The production electrical foreman has the option of installing cables in a unit and coiling the ends of the cables for future installation through adjacent units as they are joined together. This technique is used on a case basis where some specific production goal can be achieved. The disadvantage of coiling cables is the disruption and inconvenience caused due to the obstruction of equipment and walkways.

Local runs of cables in a unit are treated as field installations and are left to the discretion of the Production Department. The production foreman can install these cables on unit or on board as dictated by his work order.

11. WIREWAY DESIGN

Wireway design is well suited to modular construction techniques. The wireway hangers, being made of steel, can therefore be phased in with the orderly erection of a unit during main assembly prior to blast and paint. In designing the wireways for "on unit" installation, ASI has experienced an increase in design time of approximately 50 percent due to the increased level of detail required for modular construction as opposed to the manner in which wireways have historically been designed. The increased effort also represents a shift in material takeoff and hole location efforts from the production foreman to the wireway designer.

In the past, wireway arrangement drawings contained the majority of information necessary to construct the hangers. Typical details of several different types of hangers were included in an electrical installation methods book for the ship. For each hanger on the wireway drawing, a hanger method would be specified along with the number of tiers, width of the hanger, depth from the overhead, and spacing to adjacent hangers. The list of material was simply a summary of the total quantity of channel iron, angle iron, flat bars and banding straps. The production foreman would use the drawing to determine the number of hangers of each specific type required. Engineering also provided master lists on bulkhead cable transits and nonwatertight collars. From these lists, the production foreman derived measurements to enable him to have the collars for the entire ship fabricated at one time. His layout crew would then install the collars and hangers to the required spacing shown on the wireway drawings and lists in a concentrated effort to install all hangers and collars for the ship at one time. Interference problems were resolved by discussion between the production foreman and the wireway designer.

Using the zone outfitting concept, wireway arrangement drawings are segmented by unit number to allow the production foreman to identify exactly which hangers are in each unit. (See Graph No. EL-l.) The list of material is no longer a summary of total material. Instead, the list of material is broken down by units to show the number of hangers of each type. Each type of hanger is detailed. Under the traditional method, approximately four types of hangers would be identified for the whole job. For zone outfitting, the number of hanger types can be in the hundreds. (See Graph No. EL-2.) Each slight variation of one hanger from another generates a new hanger detail. The end result of the additional detailing is to generate a unique piece mark number for each hanger which can then be entered into a computer program for tracking purposes by Production Planning and Management. Ultimately, it would then be possible to know how many hangers of each type are available in the yard for all jobs. This would allow stock- piling of commonly used hanger types and reduce disruption of the work flow on a given job when requirements for new hangers are generated after the bulk of the hangers for the job have already been constructed. It would be possible to screen all jobs to locate presently unused hangers of the type needed for the new hanger requirements.

The fabrication and installation of wireway non-watertight collars is an area where zone outfitting has made a significant contribution. Using the traditional manner of collar fabrication, the production foreman obtained dimensions from hole lists and then had the collars constructed by a specialist in his electrical department. Before installation of the collars in the bulkheads, the holes would be burned out by his layout crew utilizing dimensions provided by the hole list. In zone outfitting, however, the production field crew's work effort is reduced considerably. Collars are standardized to a limited number of commonly used sizes.

Early in the design of the vessel, dimensional information for numerical hole cutting by automatic burning machines is provided to the Mold Loft. This allows the holes for the wireways to be accurately cut by the automatic burners during the erection of the unit in main assembly. Effectively, the electrical field production crew's responsibility for non-watertight collar fabrication and installation is reduced to simply obtaining the pre-cut non-watertight collars and installing these collars in pre-cut holes. A logical extension of this work reduction effort would be to remove the electrical work crew completely from the process by having the collars installed by the steel workers during erection of the unit.

Collars for bulkhead transits are still made in the traditional manner due to the close tolerances required to fit the transit to the collar. However, the holes for these collars are also numerically cut by the automatic burning machines. Watertight collars represent a small percentage of the total number of collars typically required for cable installations throughout a ship. Therefore, fabrication of collars for watertight transits is not presently seen by ASI as a significant inconvenience, but it probably will be an area in the future where further standardiztion will be investigated. AI.SO, the increasing usage of the Geaquello method filled collars for watertight penetrations further reduces the number of transits required. Since these collars do not use transits, their fabrication can be done in the same manner as non-watertight collar fabrication. (See Graph No. EL-3.)

The net result of the increase in engineering effort in wireway design is to reduce the complexity of the wireway installation to the electrical production crew, thereby allowing the use of less skilled workers doing less manual labor than the traditional method of wireway installation.

III. DRAWING FORMAT CHANGES

To facilitate zone outfitting, the formats of electrical deck plans and isometric wiring diagrams have been revised to include additional unit construction information. Previously, these drawings depicted the electrical system in the body of the plan with a list of materials which listed total quantities for the material distributed throughout the drawing. For zone outfitting. However, these same drawings now have leader. lines in the body of the plan which segment the ship into the various zones. (See Graph No. EL-4.) Also, the front of the drawing has a table above the title block which flags for cursory drawing reviewers that the drawing contains material which must be installed in any of twelve different stages of construction; such as, during subassembly on unit, or before closing in on board. As a further aid, the title block itself identifies the ship zones affected by the electrical system shown on the drawing.

The list of material for deck plans and isometric drawings is subdivided by the pallet codes associated with each unit or zone. (See Graph No. EL-5.) Under each pallet code is listed the electrical material contained on the drawing which will be installed in that particular unit or zone. An exception to this technique of material listing is the listing of cable quantities. Cables are summarized at the end of the list of material with no reference to any particular unit or zone. The reason for this apparent anomoly is related to the manner in which cable is handled and installed in the shipyard. Cables are purchased, stored, and transported to the worksite on reels. As the cable is being installed, the electrical crew cuts the length required for the installation from the reel. The production foreman coordinates the overall cable installation to minimize cable waste. Since cable is expensive and is a long lead item for procurement, cable footage must constantly be monitored. Therefore, to identify specific cable lengths in each pallet would not contribute to a more efficient, less costly installation.

On some isometric wiring diagrams, such as the general alarm system, there exists a sizeable number of identical pieces of electrical equipment distributed throughout many of the zones on the ship. If the list of materials was divided based on the different pallets, the resulting list would be excessively long. To alleviate this problem, a matrix arrangement for identical equipment in a list of material has been devised. (See Graph No. EL-6.) Each equipment piece mark number is listed for horizontal rows and pallet codes are listed for the vertical columns. A number placed in the field of the matrix would indicate the quantity of a specific piece mark number for a specific pallet. Present piece mark numbers used for electrical equipment at ASI remain identical to the numbering system used in the past. However, when the computer program associated with zone "outfitting develops to the point where a particular numbering system for electrical equipment can be utilized, then that numbering system will be used on future ship construction projects.

Keeping the body of the deck plan and isometric wiring diagrams substantially the same as on previous jobs allows an easy transition of production workers into the new technique of zone outfitting. Also, the drawings have not become so specialized and fragmented that they would be unsuitable for system review by representaives of the various cognizant regulatory bodies and owners, who may be unfamiliar with zone outfitting.

IV. PACKAGE UNITS

Machinery package units constructed by the shipyard require coordination during the design phase of a job to insure that all devices belonging on the package unit are installed during assembly of the package unit. Typical electrical devices which are installed on the package unit are motors, motor controllers, pushbutton stations, solenoids, sensors, and heat tracing cabling. The locations of these devices are established by the package unit designers with inputs supplied from the various engineering disciplines, including electrical.

Particular attention is paid to electrical equipment and cabling which will be installed on tanks, that are a part of the package unit, to insure that the proper provisions have been made for foundations and cable studs. Since the tank will be fully constructed and tested before it leaves the package unit shop, any welding to the tank exterior in the field would result in damage to the tank interior coating and require the tank being retested.

In some instances, the machinery package unit is designed before certified drawings are received from the electrical equipment vendors. To minimize the disruption to the package unit design, the size of devices such as motor controllers and pushbutton stations is estimated based on previous experience with the particular equipment. Also, by using motor control centers, many of the vagaries of motor controller sizes are eliminated as the controllers would then be part of a motor control center remote from the package unit.

Electrical heat tracing of piping systems, such as for fuel oil, is often a requirement of the ship's specification. On jobs before zone outfitting, the electrical heat tracing vendor was given piping working plans for entire systems with mark-ups for the specific pipes which required heat tracing. From these marked-up plans, the vendor developed his electrical working drawings for heat tracing material and cabling installation. Consequently, the vendor's installation plans and materials arrived late in the design of the vessel. To allow the machinery package units to leave the package unit shop as complete as possible, it has been decided to provide the package unit drawings "on an individual basis to the heat tracing vendor as soon as these drawings become available.

On the main deck of a tanker presently being designed at AS I, there are a number of pipe rack package units. As an integral part of these pipe rack package units are a number of wireways. In the past, wireways were provided for the main deck based on capacity requirements of the wireways at various points along the main deck. This technique allowed wireway sizing to proceed in the early stages of the ship design without the knowledge of exact locations of equipment on the main deck. It was left to the production foreman to run local runs of cables from the wireways to individual pieces of equipment scattered around the main deck. Since the pipe rack package units are essentially complete when installed on the ship, exact locations of main deck cabling must be known much earlier in the contract to allow the wireway development to be complete on the pipe rack package units. This requires a significant increase in the work effort of the wireway designer, since he must now determine exact locations of electrical equipment and provide small branch wireways to this equipment from the main wireway runs. (See Graphs No. EL-7 and EL-8.)

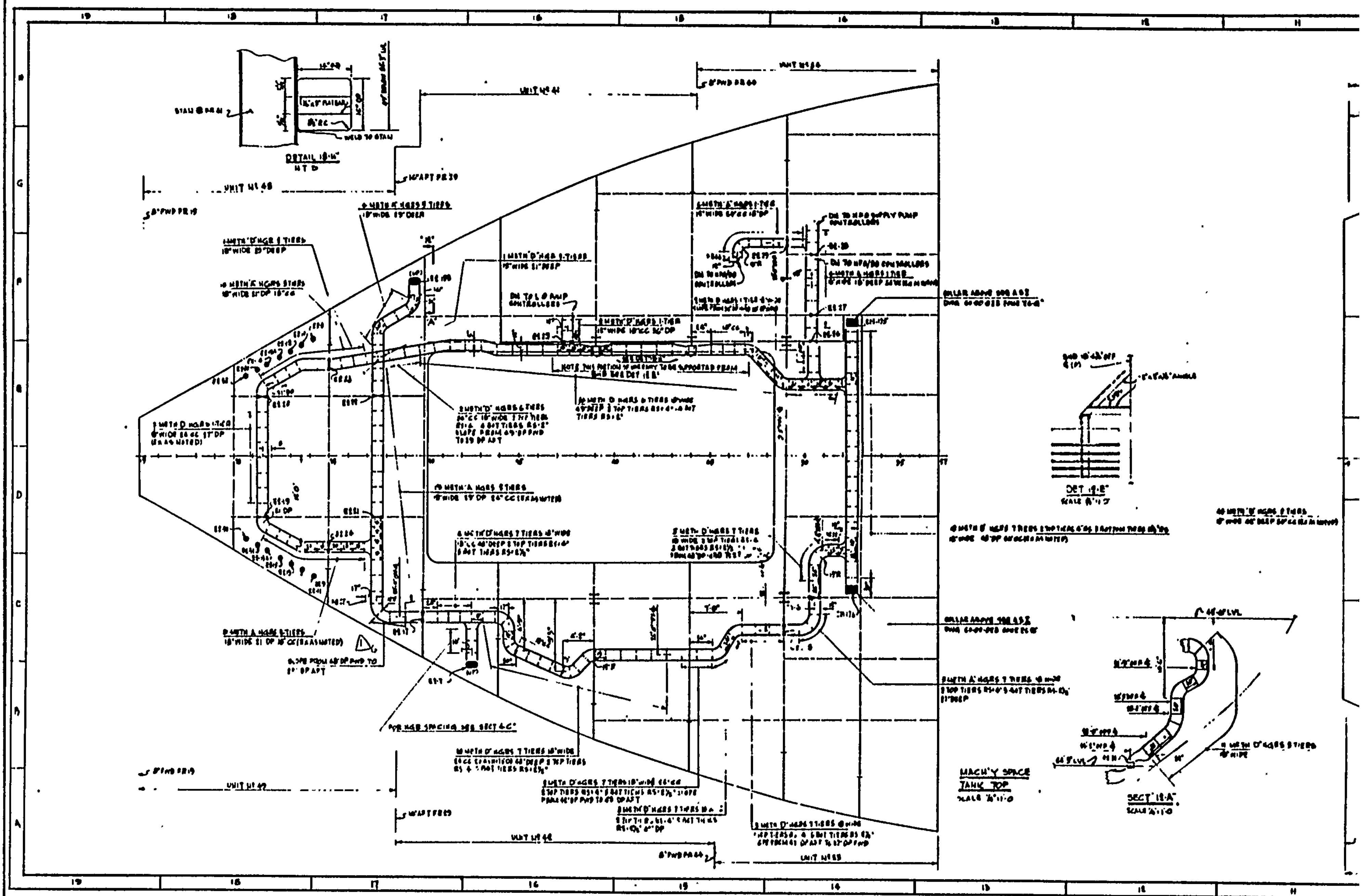
In keeping with the zone outfitting concept, it is necessary that vendor-furnished package units be supplied as complete as possible. Typical vendor-furnished package units would be such machinery as purifiers, propulsion engines, engine-generator sets, and reduction gears. For example, propulsion engines have been supplied to the shipyard in the past with numerous sensors not installed on the engine, even though they were required by the ship's specification. Also, electrical devices on the engine were not wired to a common connection point. After installation of the engine on the ship, it then became the field production crew's responsibility to mount the missing sensors and to run cabling over the surface of the engine. To obtain a complete package unit, the vendor is now required by his purchase order to furnish and install all of the electrical devices on his equipment and to wire these devices out to a common point, such as a connection box, where shipyard cabling can terminate. During vendor plan approval, his design is checked to confirm that ASI'S electrical production crew will have minimal work effort to connect to the engine electrical devices.

V. ADDED ELECTRICAL ENGINEERING RESPONSIBILITIES

Other Electrical Engineering Section responsibilities are generated due to the implementation of zone outfitting. One of these added responsibilities is the Electrical Engineering Section's participation in the pre-engineering phase of the job on an "as needed" basis. A typical example would be the generation of the one-line diagram by the shipyard's Marketing Department. Electrical Engineering drafts the one line diagram based on the conceptual ideas obtained from Marketing and provides comments to Marketing on the suitability of the design based on previous experience with various regulations and Production Department requirements. The finished one-line diagram then becomes a contract document.

Another responsibility of the Electrical Engineering Section is to provide meaningful and timely interface with other Engineering groups during the development of engineering designs. Traditionally, the bulk of electrical engineering design is started long after most of the other Engineering groups have completed substantial portions of their designs. However, to develop accurate zone outfitting type designs, it is necessary for the Electrical Engineering design cycle to shift forward in time to keep pace with other Engineering disciplines.

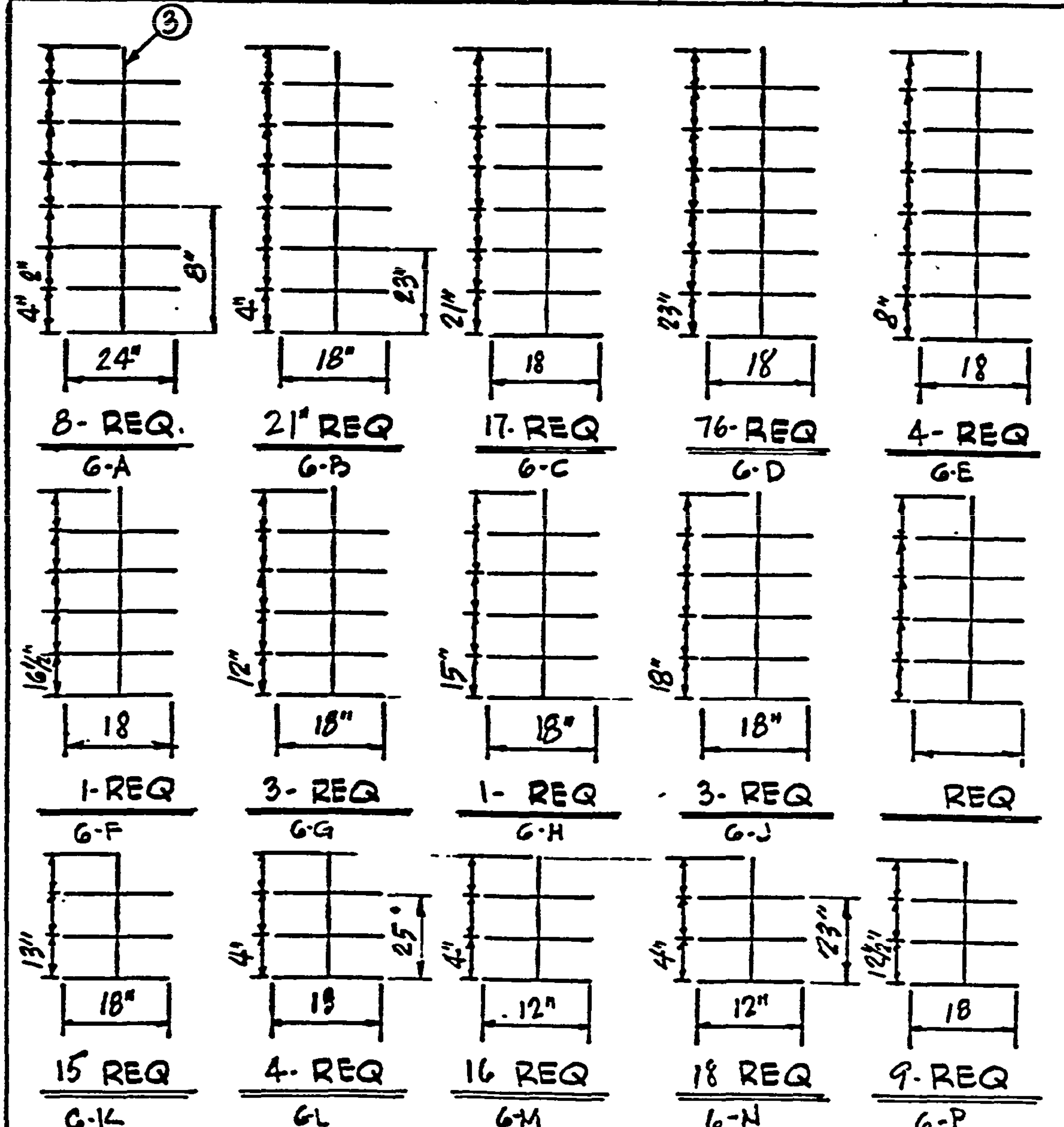
A further responsibility of the Electrical Engineering Section is to participate in construction planning meetings with the Production Planning group of the Production Department. In these meetings, potential problems and cost savings ideas are discussed, and engineering designs for the job are reviewed. As has often happened, the Production Department can request modifications to the designs to facilitate ease of installation. Engineering is expected to honor these requests, if at all possible, even though it means, in many casesj that drawings must be remade. Also, Electrical Engineering is expected to review Production Planning erection summaries for possible comment.


DETAIL 18-H
UNIT NO 48
UNIT NO 49
UNIT NO 46
DET 18-B
MACH'Y SPACE
TANK TOP
SECT 18-A

EL-1

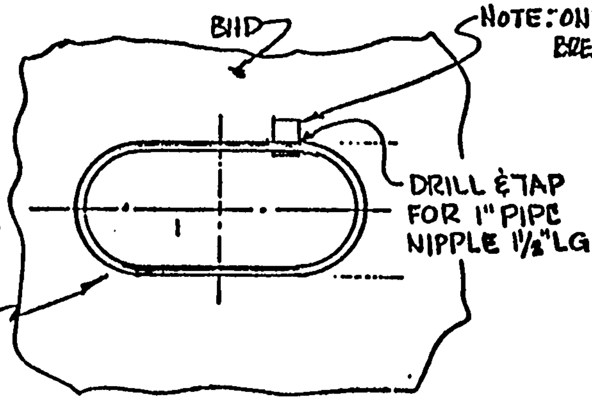
EL-2

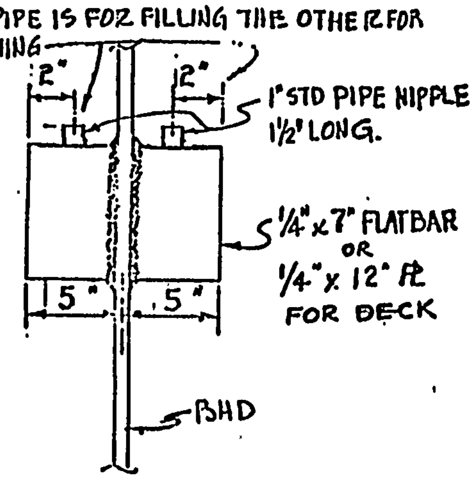
PC Nº	DESCRIPTION	QTY	MATERIAL	REMARKS
1	1¼" × ½" × ⅛" CHANNEL 18" LONG	225	MILD STL	
2	1¼" × ½" × ⅛" CHANNEL 12" LONG	34	(Do)	
3	2" × 2" × ¼" ANGLE	2721	(Do)	
4	3" × 5.0# CHANNEL	72'	(Do)	
5	BANDING STRAP	1,079'	STL. STEEL	
6	BANDING BUCKLE	259	(Do)	
7	1¼" × ½" × ⅛" CHANNEL 24" LONG	16	MILD STL	
8				
9	E4-54, E4-55			
10	E4-21, E4-22-E432 THRU E4-43, E4-50 E4-51			



SH. Nº 6	DWG Nº CH5-60-00-04 (LIN)	UNIT Nº 403	PALLET Nº [illegible]

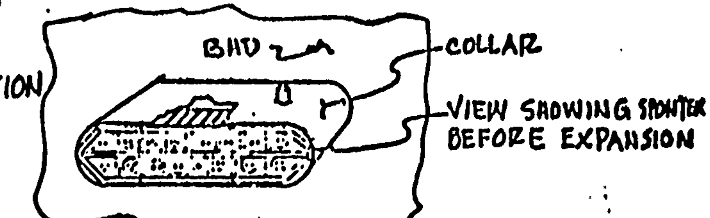
WHEN USING THIS METHOD IN DECK THE FILLING & BREATHING PIPES TO BE OMITTED & DAMMING PROCESS TO BE AT BOTTOM ONLY & FILLING COMPOUND TO BE FROM THE TOP OF COLLAR



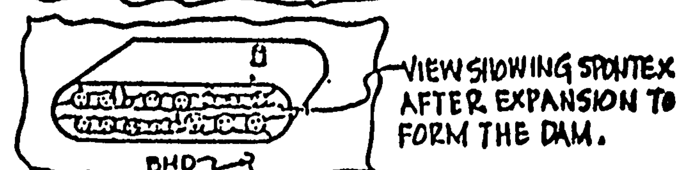


NOTE: BEFORE POURING COLLAR WITH THE GEAQUELLO FILLING COMPOUND, BOTH ENDS OF THE COLLAR IS TO BE DAMMED WITH SPONTEX SWELL MODULE.

THE SPONTEX IS TO BE FITTED AROUND CABLE & IS TO BE SPRAYED WITH GEAQUELLO IMPREGNATION LIQUID SO THAT THE SPONTEX CAN EXPAND FOR DAMMING FOR THE POURING PROCESS.



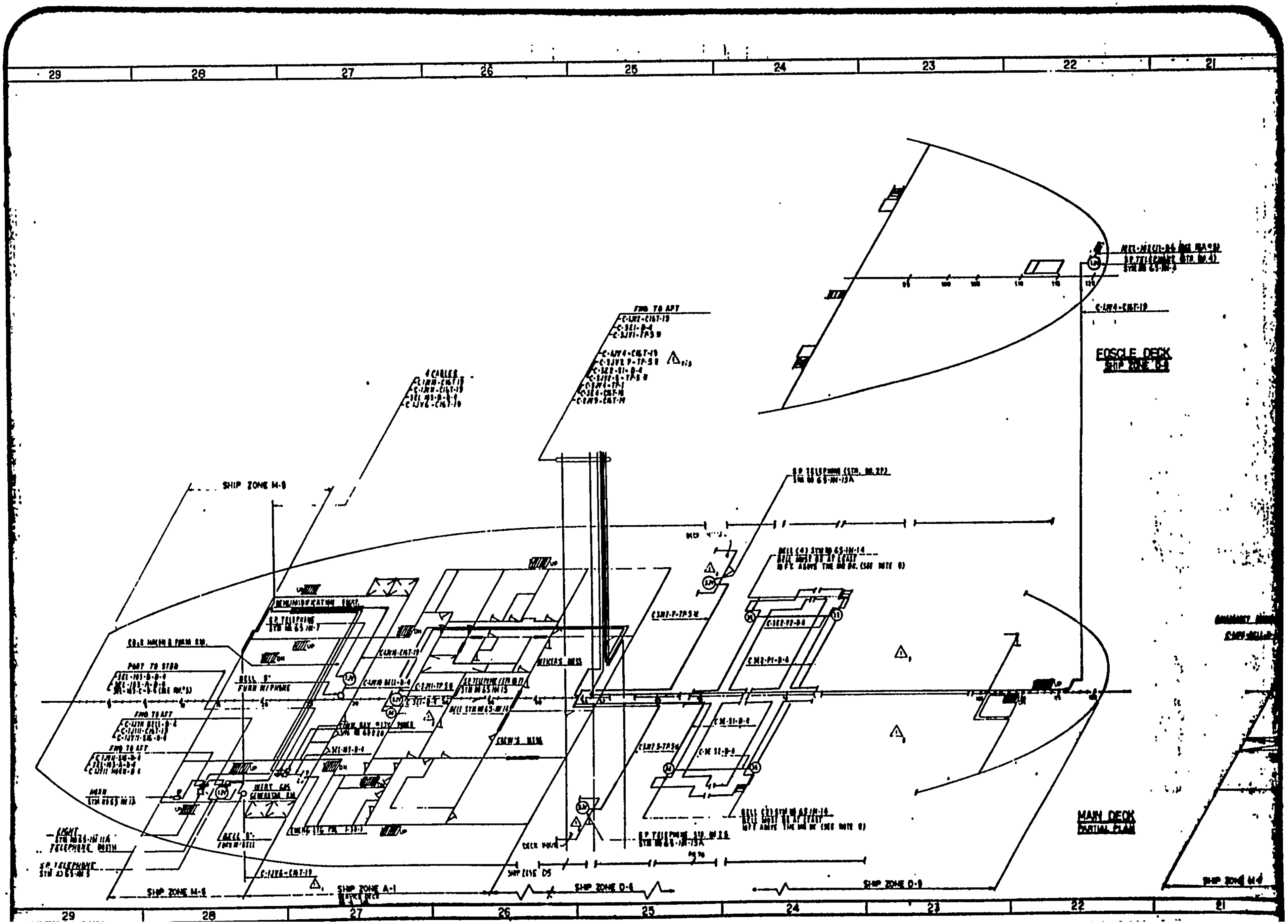
METHOD OF PENETRATING W.T., GAS TIGHT OR CLASS "A-60" BHDS OR DECKS USING THE GEAQUELLO SYSTEM



SIZE	REVISION	ASI DWG NO
A		C1·15 60-00-01
		SH NO 19

A-HVS-C (10-78)

EL-3



29
28
27
26
25
24
23
22
21
FOSCLE DECK
SHIP ZONE M-8
FWD TO AFT
4 CABLES
PORT TO STBD
BELL 8"
FWD TO AFT
SHIP ZONE M-6
SHIP ZONE A-1
SHIP ZONE D-6
SHIP ZONE D-8
CREW'S MESS
MAIN DECK
PARTIAL PLAN

10 9 8 7

[illegible] LIST (QUANTITIES FOR ONE [illegible])

SYMBOL	SYMBOL NO.	DESCRIPTION		QTY	MFR.	CAT. NO.	REMARKS
		PALLET NO. 08-D-50-01Y					
64-1-25	64-1-25	DX FIXTURE-FLUOR.(2-60W-T12-HO) SURF MTD. W/(2) 3/4" HUBS AT WIRING END, COPPER FREE ALUMINUM	EP	8	PAULUHN	FEP-260-VOP-TCF	
⊕	64-1-24	DX FIXTURE-INCAND.(1-100W-A21-RS) SURF MTD. W/(4) 3/4" HUBS, GLOBE, GUARD & SHALLOW DOME REFLECTOR, COPPER FREE ALUMINUM, SUIT FOR GROUP C&D HAZARD AREA	EP	7	KILLARK	HKGS-2-100	
64-1-26	64-1-26	DX FIXTURE-FLUOR.(2-60W-T12-HO) SURF MTD W/(2) 3/4" HUBS AT WIRING END, COPPER FREE ALUMINUM W/SPECIAL EXTERIOR CORROSION PROTECTION.	EP/WT	4	PAULUHN	FEP-260-VOP-TLT-WP	
Ⓞ	64-6-33	FLOODLIGHT-QUARTZ,(1-500W-PAR 56) 115 VAC, BRASS, SURF MTD. W/6 FT. OF 3 COND. PORT. CABLE	WT	2	RUSSELL & STOLL	F-29300	
⊠	62-2-25	CONN BOX-THICK WALLED, 8 1/2" × 10" × 6 7/8", CU FREE ALUM, W/NEOP. GASKET.	WT/EP	2	CROUSE-HINDS	GUB260-SA-5302	
⊠	62-2-26	CONN BOX-4 WIRE, BRASS, SURF MTD.	WT	2	PAULUHN	574-T-4	
—+—	62-2-75	SEAL FITTING-3/4" COPPER FREE ALUM, MALE & FEMALE, HORIZ. & VERT.	EP	42	KILLARK	EYS-2-T	USE W/W.T. CONNECTOR KILLARK "2Y-53"
■	62-2-84	SWITCH-DPST, 125 VAC, 20A, SURF MTD, CU FREE ALUM, 3/4" HUBS THRU-FEED.	EP	2	KILLARK	XS-52C	
		PALLET NO. 08-D60-01Y					
⊕	64-1-24	DX FIXTURE-INCAND.(1-100W-A21-RS) SURF MTD. W/(4) 3/4" HUBS, GLOBE, GUARD & SHALLOW DOME REFLECTOR, COPPER FREE ALUMINUM, SUIT FOR GROUP C&D HAZARD.	EP	7	KILLARK	HKGS-2-100	
64-1-26	64-1-26	DX FIXTURE-FLUOR.(2-60W-T12-HO) SURF MTD W/(2) 3/4" HUBS AT WIRING END, COPPER FREE ALUMINUM W/SPECIAL EXTERIOR CORROSION PROTECTION	EP/WT	13	PAULUHN	FEP-260-VOP-TLT-WP	
Ⓞ	64-6-35AC	FLOODLIGHT-MERCURY VAPOR (1-1000W-H36 GW-1000/DX) 460 VAC, W/2-250W-250 Q/CL LAMPS, INTEGRAL HPF CONSTANT WATTAGE BALLAST & MTG. BASE.	WT	16	NORTH STAR	SFAM855M-480C-LS C6-51-CT-2055-20B	
⊠	62-2-26	CONN BOX-4 WIRE, BRASS, SURF MTD.	WT	7	PAULUHN	574-T4	
—+—	62-2-75	SEAL FITTING-3/4" COPPER FREE ALUM, MALE & FEMALE, HORIZ. & VERT.	EP	31	KILLARK	EYS-2T	USE W/W.T. CONNECTOR KILLARK "2Y-53"
		PALLET NO. 08-D70-01Y					
64-1-5	64-1-5	DX FIXTURE-FLUOR.(2-20W-T12) SURF MTD. W/HI-IMPACT, ACRYLIC, CLEAR PRISMATIC DIFFUSER, SUIT FOR THRU FEED W/D-10 CABLE.	DP	5	RUSSELL & STOLL	LFS-220	
64-1-6	64-1-6	DX FIXTURE-FLUOR.(2-40W-T12) SURF MTD. W/HI-IMPACT, ACRYLIC, CLEAR PRISMATIC DIFFUSER, SUITABLE FOR THRU FEED W/D-10 CABLE.	DP	2	RUSSELL & STOLL	LFS-240	
■	62-2-14	RECEPTACLE-DOUBLE, 120 VAC, 20A, 2W, 3P, ANGLE TYPE, SURF MTD. BRASS	WT	1	PAULUHN	2634	
		PALLET NO. 08-D90-01Y					
64-1-5	64-1-5	DX FIXTURE-FLUOR.(2-20W T12) SURF MTD. W/HI-IMPACT, ACRYLIC, CLEAR PRISMATIC DIFFUSER, SUIT FOR THRU FEED W/ D-D CABLE.	DP	22	RUSSELL & STOLL	LFS-220	
⊗	64-1-15	DX FIXTURE INCAND.(1-100W-A21-RS) SURF MTD. BRASS, W/GLOBE, GUARD & SHALLOW DOME REFL.	WT	1	RUSSELL & STOLL	LVJBDS-R155A	
64-1-25	64-1-25	DX FIXTURE-FLUOR.(2-60W-T12-HO) SURF MTD. W/(2) 3/4" HUBS AT WIRING END, CU FREE ALUM.	EP	11	PAULUHN	FEP-260-VOP-TCT	
⊕	64-1-24	DX FIXTURE-INCAND.(1-100W-A21-RS) SURF MTD. W/(4) 3/4" HUBS, GLOBE, GUARD & SHALLOW DOME REFLECTOR, COPPER FREE ALUMINUM, SUIT FOR GROUP C&D HAZARD AREA.	EP	7	KILLARK	HKGS-2-100	
64-1-26	64-1-26	DX FIXTURE-FLUOR (2-60W T12 HO) SURF MTD W/(2) 3/4" HUBS AT WIRING END COPPER FREE ALUMINUM W/SPECIAL EXTERIOR CORROSION PROTECTION.	EP/WT	16	PAULUHN	FEP-260-VOP-TLT-WP	
Ⓞ	64-6-34C	FLOODLIGHT-MERCURY VAPOR (1-400W-H33-L-400/DX) 115 VAC, W/2 250W-250Q/CL LAMP, INTEGRAL HPF CONSTANT WATTAGE BALLAST & MTG. BASE.	WT	2	NORTH STAR	SFAM675M 120C LS-C6-51-CT-2055-20B	
Ⓞ	64-6-35C	FLOODLIGHT-MERCURY VAPOR (1-1000W-H36 GW-1000/DX) 115 VAC, W/2-250W-250Q/CL LAMPS, INTEGRAL HPF CONSTANT WATTAGE BALLAST & MTG. BASE.	WT	8	NORTH STAR	SFAM855M-120C-LS C6-51-CT-2055, 20B	
64-1-6	64-1-6	DX FIXTURE-FLUOR.(2-40W-T12) SURF MTD, W/HI IMPACT, ACRYLIC, CLEAR PRISMATIC DIFFUSER, SUITABLE FOR THRU FEED W/D-10 CABLE.	DP	3	RUSSELL & STOLL	LFS-240	
■	62-2-14	RECEPTACLE-DOUBLE, 120 VAC, 20A, 2W, 3P, ANGLE TYPE, SURF MTD. BRASS.	WT	4	PAULUHN	2634	
⊠	62-2-26	CONN BOX-4 WIRE, BRASS, SURF MTD.	WT	7	PAULUHN	574-T-4	
■	62-2-52	SWITCH-ROT-SNAP, DPST, 125 VAC, 10A SURF MTD, BRASS.	WT	2	PAULUHN	1871	
■	62-2-64	CONTACTOR-4 POLE, 30A, N.O. 120 VAC.	DP	5	ITE-ROWAN	C3M-22003340AA	
—+—	62-2-75	SEAL FITTING-3/4" COPPER FREE ALUM, MALE & FEMALE, HORIZ & VERT.	EP	70	KILLARK	EYS-2T	USE W/W.T. CONNECTOR KILLARK "2Y-53"
■	62-2-84	SWITCH-DPST, 125 VAC, 20A, SURF MTD, CU FREE ALUM, 3/4" HUBS THRU FEED.	EP	3	KILLARK	XS-52C	
		SWITCH ENCLOSURE BRASS SURF MTD 12" × 12" × 8"	WT	2	PAULUHN	590	(SEE GR. #7)
		CABLE					
	D-6	DEW-6(IEEE-45(1977)) TYPE ALUMINUM ARMOR		2300'			
	D-10	DEW-10(IEEE-45(1977)) TYPE ALUMINUM ARMOR		2300'			
	D-16	DEW-16(IEEE-45(1977)) TYPE ALUMINUM ARMOR		300'			
	D-33	DEW-33(IEEE-45(1977)) TYPE ALUMINUM ARMOR		800'			
	F-4	FEW-4(IEEE-45(1977)) TYPE ALUMINUM ARMOR		1000'			
	F-6	REW-6(IEEE-45(1977)) TYPE ALUMINUM ARMOR		1400'			
	F-10	FEW-10(IEEE-45(1977)) TYPE ALUMINUM ARMOR		1000'			

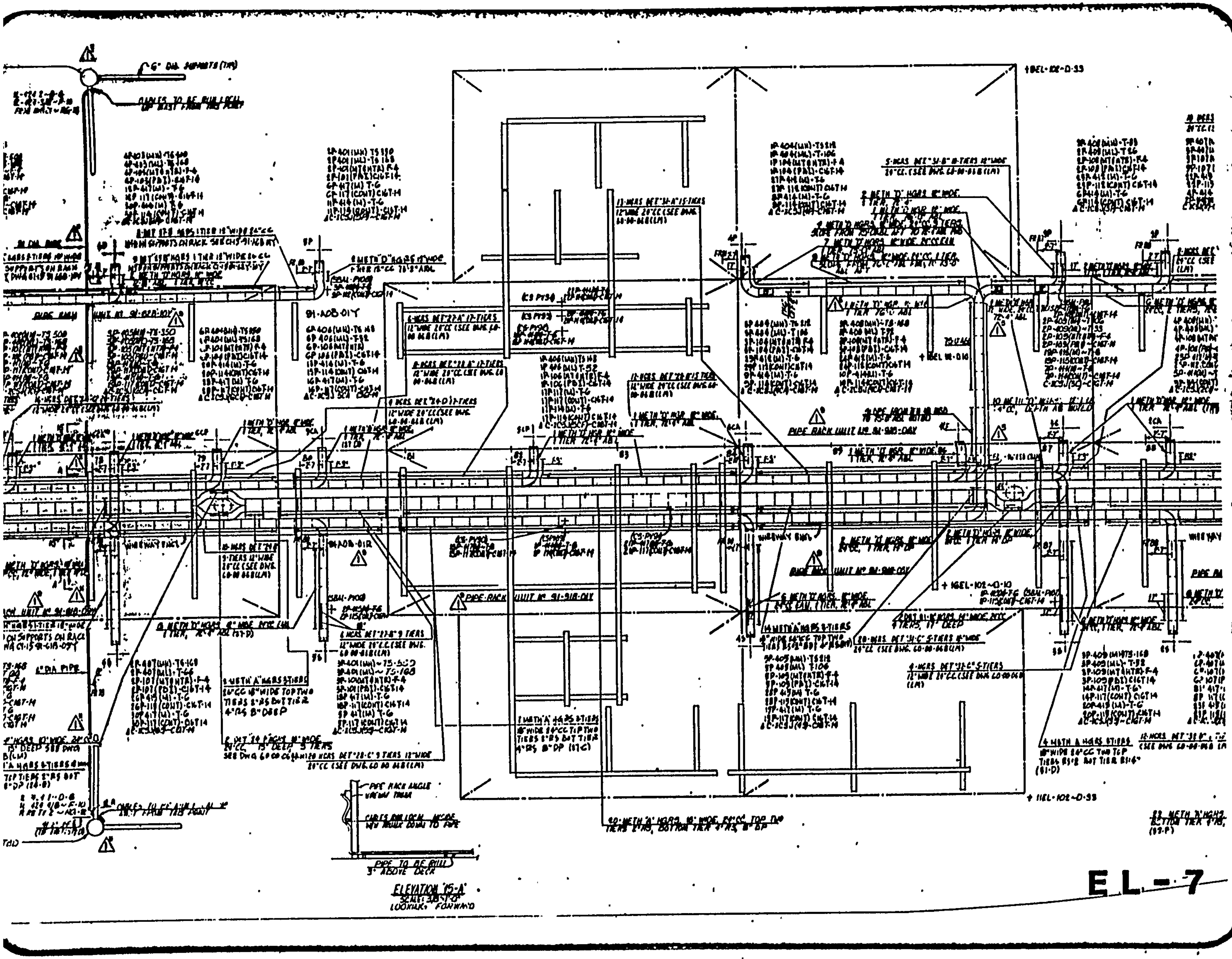
EL-5

TABLE 1

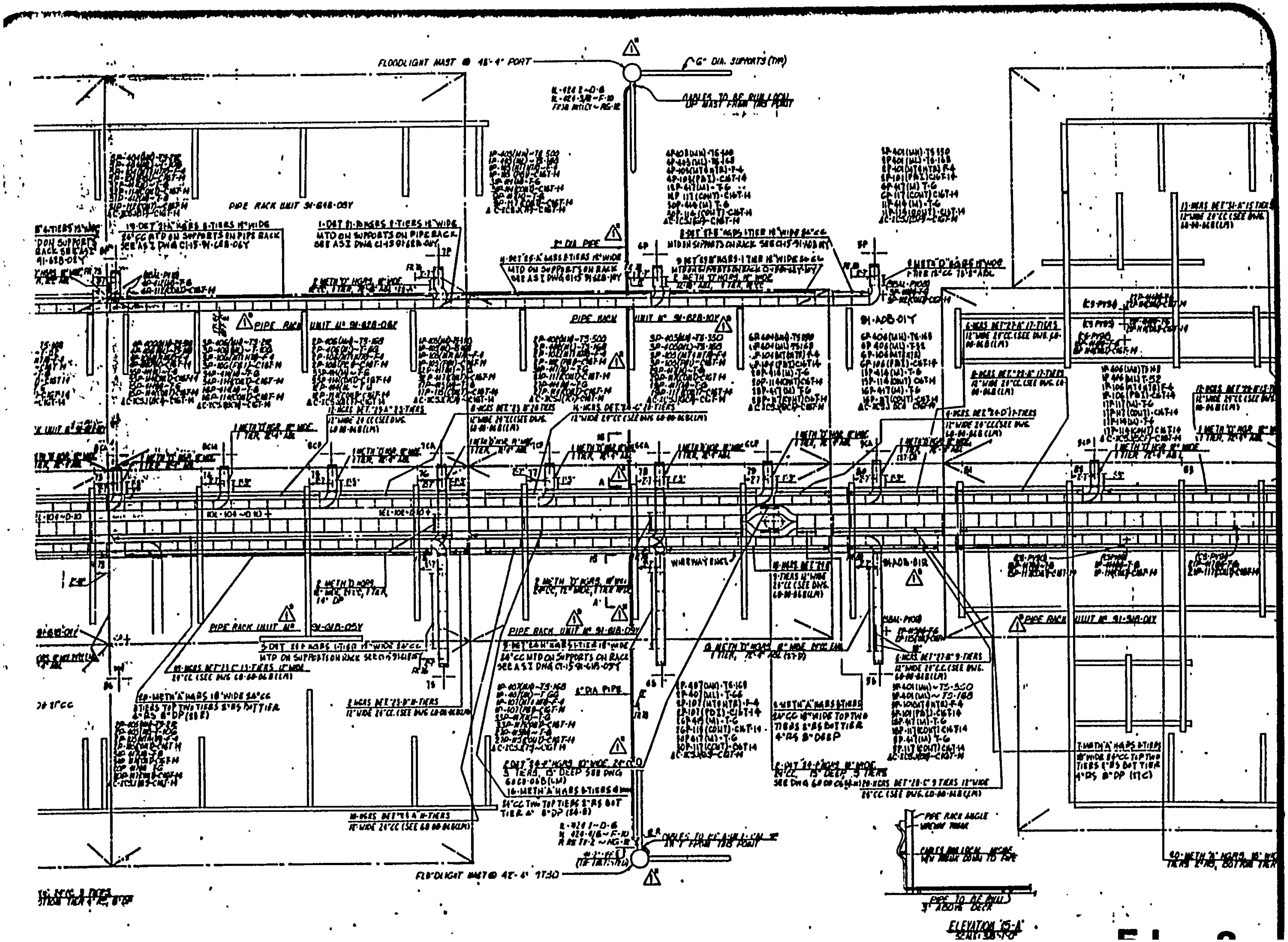
NUMBER OF UNITS IN EACH ZONE (DOES NOT INCLUDE VENDOR INSTL.)

PALLET NO. 08-(SHIP ZONE)0-1Y

DESCRIPTION	SYMBOL NO.	SHIP'S ZONES A-1	A-2	A-3	A-4	A-5	A-6	D-5	D-9	M-2	M-3	M-4	M-6	M-7	M-5	M-1	D6
STOWAGE BOX	65-101-1		1														
S.P. TEL.	165-101-2						2				2						
S.P. TEL.	65-101-3		1		2	2	1										
S.P. TEL.	65-101-4								1								
S.P. TEL.	165-101-5									1			1	1			
S.P. TEL.	165-101-6														2		
S.P. TEL.	165-101-7												1				
BOW TEL. DISC. SW.	65-101-8						1										
S.P. TEL.	165-101-9																
S.P. TEL.	165-101-10						2										
LIGHT	65-101-11A									1			1	1	1		
LIGHT	165-101-11B														1		
HORN	65-101-12									4	4	2	1	1	1	3	
TEL. BOOTH	165-101-13									1			1	1	1		
BELL	165-101-14	1															4
P.B. & JACK BOX	65-101-15	1															
4 TERM. J.B.	65-101-16									1			1		1		
HANDSET & HOOK	65-101-17						4					2					
20 TERM. J.B.	62-2-29				1							1					
52 TERM. J.B.	62-2-90		1														
S.P. TEL.	65-101-18					1											
HORN	65-101-19									5	4	2			1	3	
P.B. & JACKBOX	165-101-15A							2									



PIPE RACK UNIT No 91-918-01Y
PIPE TO BE RUN 3" ABOVE DECK
ELEVATION "15-A"
LOOKING FORWARD
EL-7


FLOODLIGHT MAST @ 48'-4" PORT
6" DIA. SUPPORTS (TYP)
CABLES TO BE RUN LOCAL UP MAST FROM THIS POINT
PIPE RACK UNIT 91-618-05Y
6" DIA PIPE
PIPE RACK
WIREWAY ENCL
PIPE RACK ANGLE
PIPE TO BE RUN 3" ABOVE DECK
ELEVATION 15-A

DESIGN ENGINEERING FOR ZONE OUTFITTING
AVONDALE SHIPYARDS, INC.

ENGINEERING PLANNING AND SCHEDULING

DESIGN ENGINEERING FOR ZONE OUTFITTING
ENGINEERING PLANNING AND SCHEDULING

1. INTRODUCTION

It is probably obvious to you at this point that in order for zone outfitting to succeed, the engineering design effort must get off to a fast start, must peak early and must remain intensive until completion. This can only be accomplished if the engineering effort is carefully planned and scheduled. At Avondale, the Engineering Planning and Scheduling Section consults with Management and Engineering section leaders and builds, maintains and monitors engineering drawing schedules and material procurement schedules. In addition, Engineerring planning and Scheduling provides management services in the areas of manhour accounting, overhead control, network analysis, technical communications, graphics and other areas. Our focus this afternoon will be on Engineering Planning and Scheduling's role in the building, maintenance and monitoring of engineering drawing schedules and material procurement schedules.

II. PLANNING "KEYS"

AS early as possible, the "keys" to planning for vessel construction are developed by the Production Planning Department and the Advanced Programs and Hull Technical and Design sections. These keys are:

Production Planning

- Production Major Milestone Dates
  including date steel required in the yard, start of prefabrication, start of main assembly (pre-outfit), date of keel laying, date of launch and date of delivery.
- Unit Arrangement
- Zone and Sub-Zone Arrangement
- Pre-Fab and Sub-Assembly Schedule
- Main Assembly and Erection Schedule

Advanced Pronares/Hull Technical and Design

- Specifications
- Midship Section
- Scantling Plan

- Scantling Section and Details
- General Arrangement
- Machinery Arrangement
- Systems Diagrams

III. DRAWING SCHEDULE PREPARATION

AS the above planning "keys" are made available, the Engineering sections review them and prepare a definition of the scope of work they must accomplish in order to provide Production with the necessary working drawings and other engineering data. This scope will include a drawing list which will indicate those drawings that Production will need and an estimate of the manhours required to do each diagram, drawing, and set of calculations. Also included in the scope are the units for which composites will be made and the estimated hours for these composite drawings.

The Engineering sections will indicate the items of information required before work can commence on diagrams, working drawings, and composite activity. This information includes diagrams, drawings, sketches, etc. from other Engineering sections, vendor drawings, and so on.

Engineering Planning and Scheduling examines the drawing list (which is forwarded to production Planning and Scheduling for need dates), required information items and the scope of the machinery and quarters composite work to determine interdependencies and priorities of diagram and drawing preparation among the Engineering sections. This is done in order to assure that the Engineering sections will support each other’s efforts. Working drawings and required composite schedules are then prepared for each section. Note that these initial schedules are prepared without benefit of Production need dates. This can be done due to the fact that although Engineering must, of course, support Production needs, the scheduling of the engineering work does not have to be dictated by Production need dates. In the early phase of contract development, it is of primary importance that the Engineering sections support each other’s efforts.

GRAPH EP-1 is the cover sheet for the initial issue of the drawing schedule for the Outfitting Section on a current contract. Note that there have been two preliminary issues of the schedule prior to the initial issue. Also note that the Production need dates were still reserved at issue of the schedule. When the schedules are originally prepared, they are on "D" size sheets (22" by 34"). They are distributed reduced to) 50% of that size (11" x 17"). The copies you have in you seminar books are, therefore, considerably smaller than the size used at Avondale. I want to apologize if they are a bit difficult to read.

GRAPH EP-2 is the Key Plan. schedule for the Outfitting Section. These drawings are required for long-lead material procurement or to support other Engineering disciplines. The schedule that is used here is of the Gantt-type with solid bars representing drafting activity and cross-hatched bars representing checking activity. The small arrows shown near the completion of drawing activity denote scheduled reviews with the Assistant Chief Engineer to monitor drawing progress.

GRAPHS EP-3, EP-4, and EP-5 are the Yard Plan schedules for the Outfitting Section. Note that where more than one man is required for drafting or checking activity, a symbol (two or more small men) is used to designate this situation. At the bottom of GRAPH EP-5 are shown the manpower requirements for the Outfitting Section for the scheduled job. The bars of the schedule are counted for each week and the required weekly totals are shown for drafters and checkers. In addition, the manhours allocated for revision activity are spread over a reasonable time frame so that manning for this activity can be anticipated. Of course, as the schedule is built, the engineer-planners take into consideration manpower availability and desired manning levels. Manpower requirements are also shown for the accommodations composite activity (see GRAPH EP-6) and a Grand Total is shown. If the schedule is manned to the levels indicated, and if the estimated manhours for the drawing activity are reasonably close, then the schedule should be met.

GRAPH EP-7 is the title sheet for the Hull Section drawing schedule. Note that four preliminary submittals were made before Rev. O went out.

GRAPH EP-8 is the Key Plan schedule for the Hull Section. Note here that accommodation has been made to handle scheduling for subgroups within the Hull Section. Therefore, activity to be per formed by the "Specialty Item Group" is differentiated from that to be performed by others in the Hull Section.

GRAPH EP-9 is a typical sheet from the Yard Plan portion on the Hull Section drawing schedule. The isometric activity shown here was cancelled at a later date, and penetration control activity was added so that this critical area of structural drawing preparation could be carefully monitored.

GRAPH EP-10 shows the conclusion of Hull Section yard plan activity and the manpower requirements for the Hull Section. Note that manpower needs are called out for each subgroup as well as for the entire Hull Section.

GRAPH EP-11 is the title sheet for the Piping Development and Machinery Composite Groups drawing schedule. This section is the largest in Avondale Engineering and produces more drawings than any other section. In order to make the scheduling and schedule monitoring more manageable, a separate schedule is built for each group within the Piping Section. These schedules are then bound together and manpower requirements can be examined for the entire section.

GRAPH EP-12 shows the Key Plans for the Piping Section.

GRAPH EP-13 is a typical sheet from the Piping Section schedule. A later revision of this schedule separated the heating coil drawings and main deck rack drawings from the other piping drawings. Note that in addition to arrangement drafting and checking activity, this schedule also shows piping detail preparation activity. Again, where more than one man is required to work on an activity, a symbol is used to show this.

GRAPH EP-14 is another typical sheet from the Piping Section drawing schedule.

GRAPH EP-I.5 is the Manpower Summary Sheet from the Piping Section drawing schedule. Note that for each subgroup the required manning is shown for drafting, checking, piping detail, and revision activity, and, of course, total. As I mentioned, the piping schedule was further subdivided in later scheduled revisions.

IV. <u>DRAWING SCHEDULE MONITORING</u>

It is not enough to build schedules, issue them with management blessing, and then assume that the job will be done as scheduled. We all know that schedules can slip due to alteratior in work scope, change orders, inadequate manning, etc. By the same token, work can sometimes move along more rapidly than expected, thus accelerating the schedule. At any rate, it is important for management that schedule activity be monitored closely and the results reported so that prompt corrective action can be taken if required. In Avondale Engineering, the Engineering Planning and Scheduling section performs this schedule monitoring function.

In order to facilitate schedule monitoring and review, drawing schedules are built with magnets on large porcelain boards in what we call the Engineering Planning and Scheduling “Operations Room. (See GRAPH EP-16.) In addition to displaying the schedule activity information which you have seen on the previous graphs, the large schedule boards also contain certain information relative to manhours spent on each drawing activity and other engineering activities.

Each week, Engineering Planning and Scheduling prepares a computer report for each schedule which shows the manhours expended against each drawing, as well as the total equivalent men worked on that schedule. (See GRAPH EP-17.) These actual charges can then be compared with the schedule to determine that sufficient manpower is being brought to bear where required. Total spending against each drawing is also monitored on the schedule boards so that the actual progress in terms of percent complete can be compared with percent of budget expended. If required, projections for manhours to be expended by drawing completion are revised at schedule reviews which are held in the "Operations Room" each week.

Spending versus actual progress is also monitored weekly for engineering activities other than drawing preparation, such as supervision, vendor review, etc. A similar computer report is generated each week for these activities. (See GRAPH EP-18.)

After each schedule review, Engineering Planning and Scheduling prepares a "Weekly Schedule Review Report" which is distributed to the section leader and Engineering management. (See GRAPH EP-19.) The report is divided into three main sections, "Drawings Behind Schedule," "Drawings Submitted Incomplete,” and “Drawings Being Worked on or Ahead of Schedule.” Drawings which fall into on= of these categories are listed by number and title, followed by twelve Columns of data:

COLUMN	**DATA PRESENTED**
1 & 2	Manhours expended since last report and cumulatively
3	Estimated hours to complete drawing activity
4 & 5	Estimate at completion for last review and present review
6	Variance between columns four and five
7	Scheduled completion date for drawing activity
8	Production need date
9,10,11	% of drawing completion scheduled/% of drawing completion actual/% of drawing completion at previous review
12	Current estimated completion date

GRAPH EP-20 is the second sheet of a typical drawing schedule review report and GRAPH EP-21 is the third sheet. Note that the comments section is used to make whatever comments Engineering Planning and Scheduling feels will be helpful to management in performing their evaluations. Note the comment which is made relative to inadequate manning on subject schedule.

V. **MATERIAL PROCUREMENT SCHEDULE PREPARATION**

As all of you are aware, the timely receipt of vendor information is critical to the design engineering process. It is even more critical (if you can imagine that) to the design engineering process which is supporting zone outfitting construction. For this reason, Engineering Planning and Scheduling builds “Material Procurement Schedules” for each Engineering section. These schedules list each item that the Engineering section is responsible for procuring and indicates when each item must be requested and when a purchase order must be placed. You must always keep in mind that the dates required for request and purchase order to satisfy timely delivery of material items to the yard for installation are more often than not too late to satisfy the demand for vendor information to Engineering. In order to build material procurement schedules, Engineering Planning and Scheduling requires the following information:

"In Yard" production need dates (from Production Planning)

Engineering Vendor Information Need Dates (from drawing schedules)

List of material items and drawing on which material appears (from Material Requisitioning Section)

Vendor lead time (from Purchasing Department)

When the above information has been received, Engineering ning and Scheduling builds and issues initial material procurement schedules for each Engineering section. GRAPH EP-22 is the title sheet for the Mechanical Design Section material p curement schedule for a current contract. GRAPH EP-23 is the revision and general notes sheet for the Mechanical Design material schedule. The legend shows the type of information to be found on the material procurement schedules:

- Scheduled Material Requisition Issue Date

- Actual Material Requisition Issue Date

- Scheduled Purchase Order Issue Date

- Actual Purchase Order Issue Date

- Vendor "Preliminary" Information Need Date
  this is vendor information typically available at P.O. issue

- Vendor "Detailed" Information Need Date
  this is vendor information typically not available until approximately 45 days after P.O. issue

- Vendor Manufacturing Lead Time

- production Need Date

- Scheduled Drawing Submittal Date

GRAPH EP-24 is a typical sheet from the Mechanical Design Section material schedule. It is admittedly difficult to read in your books and on the screen due to its reduction; however," I wanted to give you a rough idea of how the schedules look. You can see that each material item is listed together with its Avondale code number, the vendor name, the item location, and the requisition and purchase order numbers (once these become available).

VI. MATERIAL PROCUREMENT SCHEDULE MONITORING

Just as with the drawing schedules, careful monitoring is required for the material procurement schedules. Each week, Engineering Planning and Scheduling receives material update information from the Material Requisitioning Section and the technical Engineering sections. This date is used to prepare a "Material Procurement Schedule Review Report" for each Engineering section. GRAPHS EP-.25 and EP-26 are typical sheets from a Mechanical Design Section material review report. Each material item is listed, followed by ten columns of data:

COLUMN	DATA PRESENTED
1	Scheduled Requisition Date
2 & 3	Actual Requisition Date/Requisition Number”
4	Scheduled Purchase Order Date
5 & 6	Actual Purchase Order Date/Purchase Order Number
7	Scheduled Vendor Preliminary Information Date
8	Actual Vendor Preliminary Information Date
9	Scheduled Vendor Detailed Information Date
10	Actual Vendor Detailed Information Date

The legend for the abbreviations and symbols used in this report is located at the top center of the title sheet. The most important symbol is the asterisk which indicates "Trouble Area - Action Required.” Like the review reports used to monitor drawing schedules, the material schedule review report is designed to provide management with an instrument that can be used to easily spot problem areas.

VII. CONCLUSION

I need to emphasize in closing that the schedules and the review reports we have discussed are tools for Management and Engineering supervision to use in running an engineering job and in monitoring its progress. Like any tool, however, the user must become familiar with it and its applications. The more often it is used, the more useful it will be. One thing is certain, and that is, as shipbuilding becomes more sophisticated and complicated, planning and scheduling becomes that much more important to the shipbuilder in both the Production and the Engineering operations.

8	7	6	5	4	3	2	1

REFERENCES

REV	NO	TITLE	DRAWING NO

OUTFITTING SECTION – DRAWING SCHEDULE
(INCLUDING ACCOMODATIONS COMPOSITE)

ASI DWG NO	REV
C1-15 11-200-01	0

INDEX

SH NO	TITLE
1	TITLE BLOCK, PRINT DISTRIBUTION, INDEX AND REFERENCES
2	[illegible] & GENERAL NOTES
3	[illegible] PLAN DRAWING SCHEDULE
4	[illegible] PLAN DRAWING SCHEDULE
5	[illegible] PLAN DRAWING SCHEDULE
6	[illegible] PLAN DRAWING SCHEDULE
7	[illegible] PLAN DRAWING SCHEDULE
8	ACCOMMODATIONS [illegible] SCHEDULE

DISTRIBUTION

DEPARTMENT	REVISION
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PROD PLANNING	
MOLD LOFT	
PLANT ENGR & MAINT	
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PROGRAM MANAGER	
QUALITY CONTROL	
ELECTRICAL	
ENGR STANDARDS	
FILES & RECORDS	
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MATERIAL ENGR	
MECHANICAL DESIGN	
MECH COMPOSITE	
ENGR PLAN & SCHED	
BAYOU BLACK	
HARVEY	
SERVICE FOUNDRY	
JOINER CONTRACTOR	
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MARAD (YARD)	
OWNER (HOME)	
OWNER (YARD)	
ABS (NY)	
ABS (NO)	
ABS (YARD)	
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MATERIAL CONTROL	
LEGAL	
TOTAL	
PARTIAL ISSUE	
DATE OF ISSUE	

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RESERVATIONS

RECORD INFO

DEV. BY ENGINEERING PLANNING AND SCHEDULING

AVONDALE SHIPYARDS INC
P O BOX 50280
NEW ORLEANS, LA
70150

DRAWN BY AJP/AJG DATE [illegible]

CHECKED BY [illegible] DATE [illegible]

APPD [illegible]

APPD [illegible] 8-7-81

ASST CHIEF ENGINEER

APPD R. G. [illegible]

PROGRAM MANAGER

AS JOB NO C1-15

[illegible] COMPANY, USA

42,000 DWT MULTI-PRODUCTS CARRIERS

OUTFITTING SECTION DRAWING SCHEDULE
(INCLUDING ACCOMODATIONS COMPOSITE)

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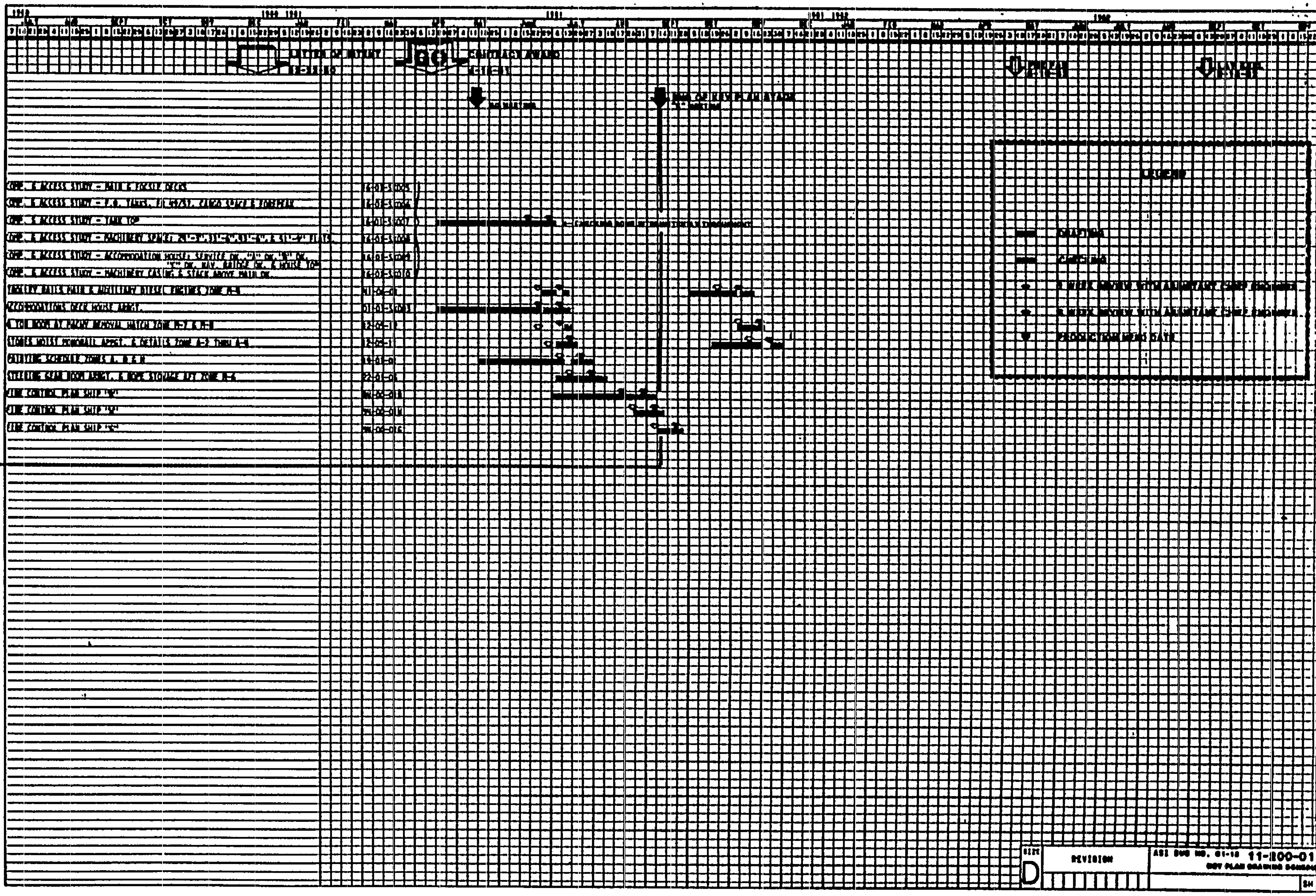
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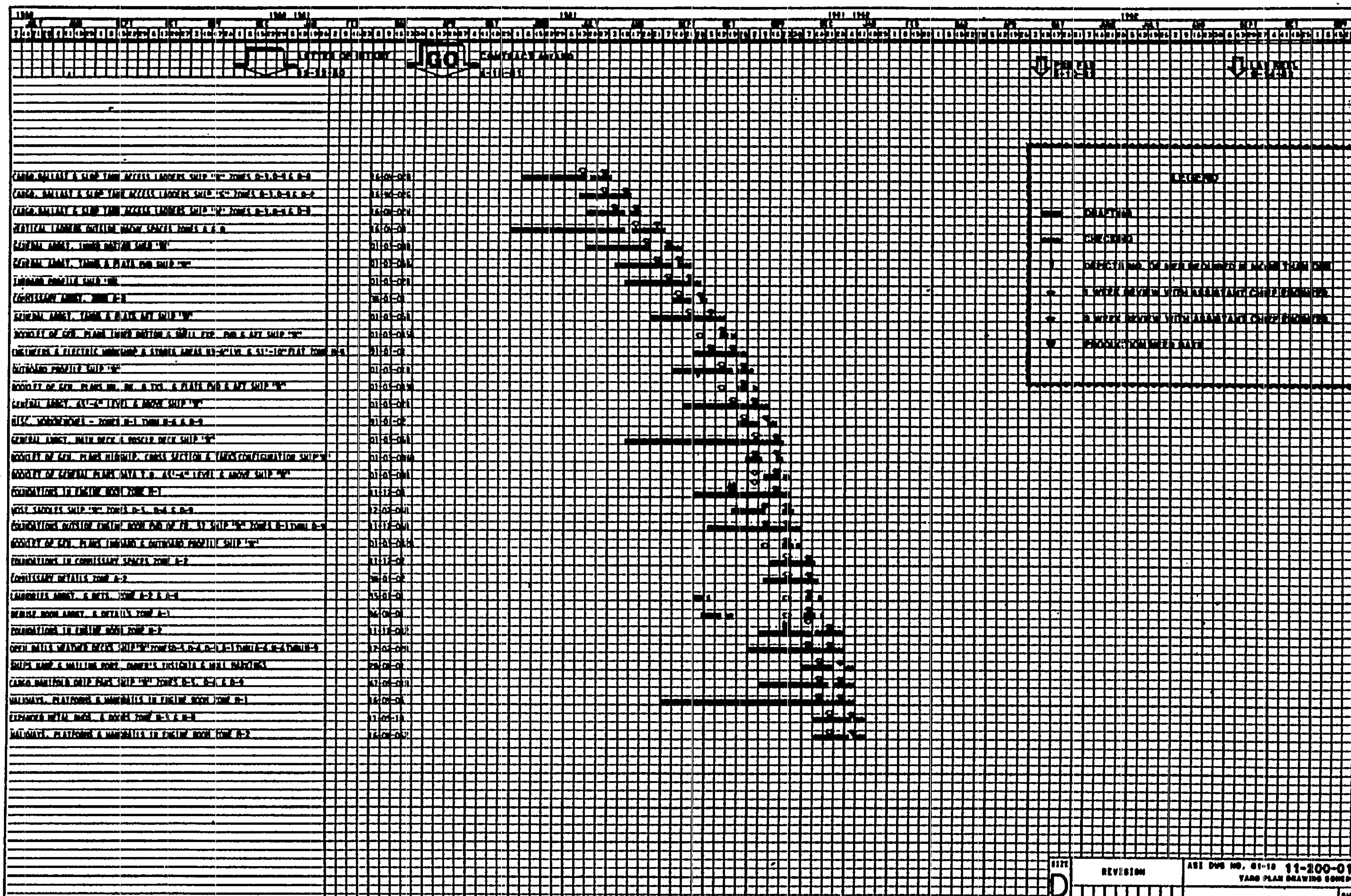
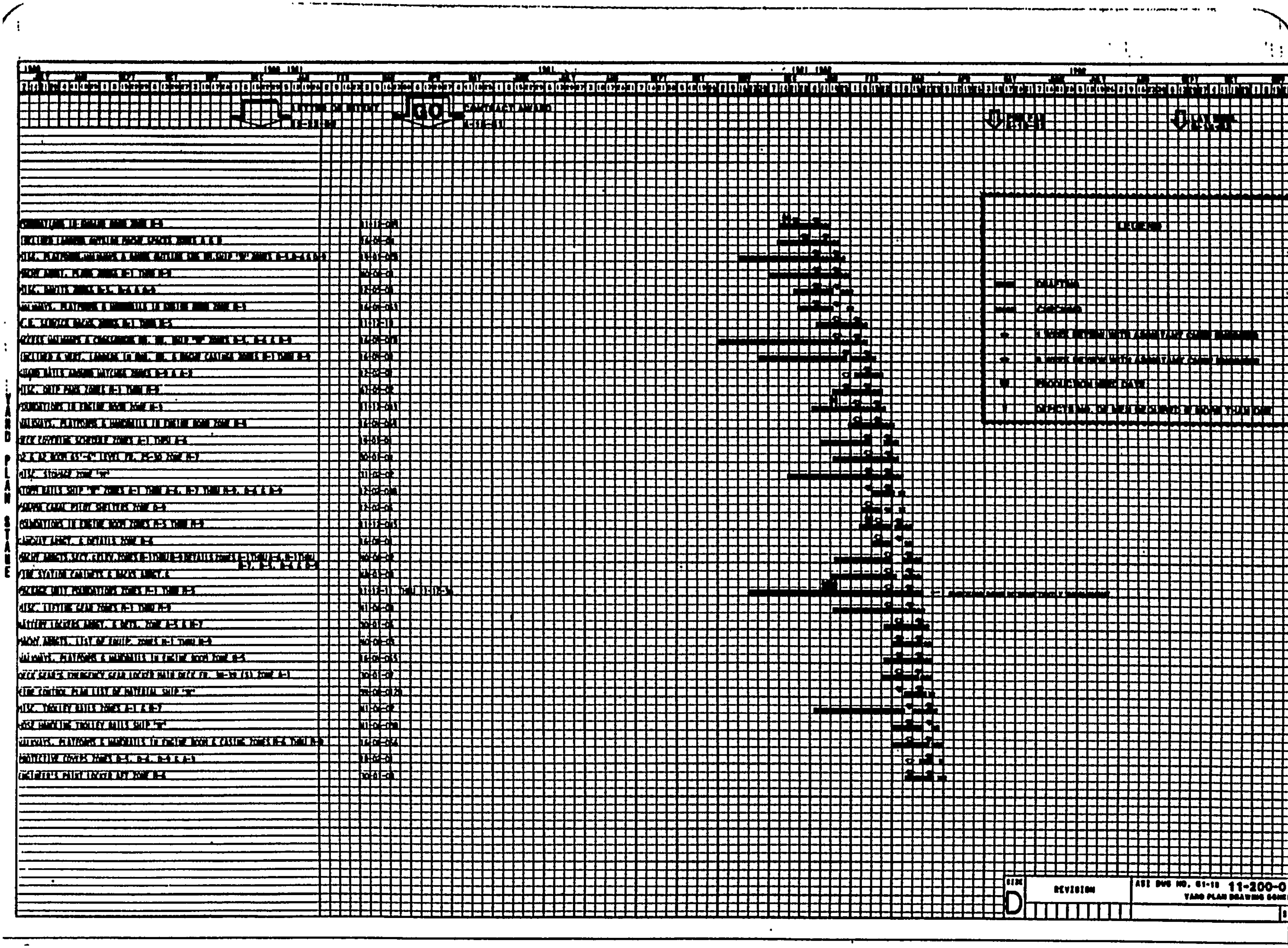
CONTRACT AWARD
KEY PLAN STAGE
COMP. & ACCESS STUDY - MAIN & FOCSLE DECKS
COMP. & ACCESS STUDY - TANK TOP
ACCOMMODATIONS DECK HOUSE ARRGT.
FIRE CONTROL PLAN SHIP "A"
FIRE CONTROL PLAN SHIP "B"
FIRE CONTROL PLAN SHIP "C"
LEGEND
DRAFTING
CHECKING
PRODUCTION NEED DATE
REVISION
D
11-800-01

EP-2

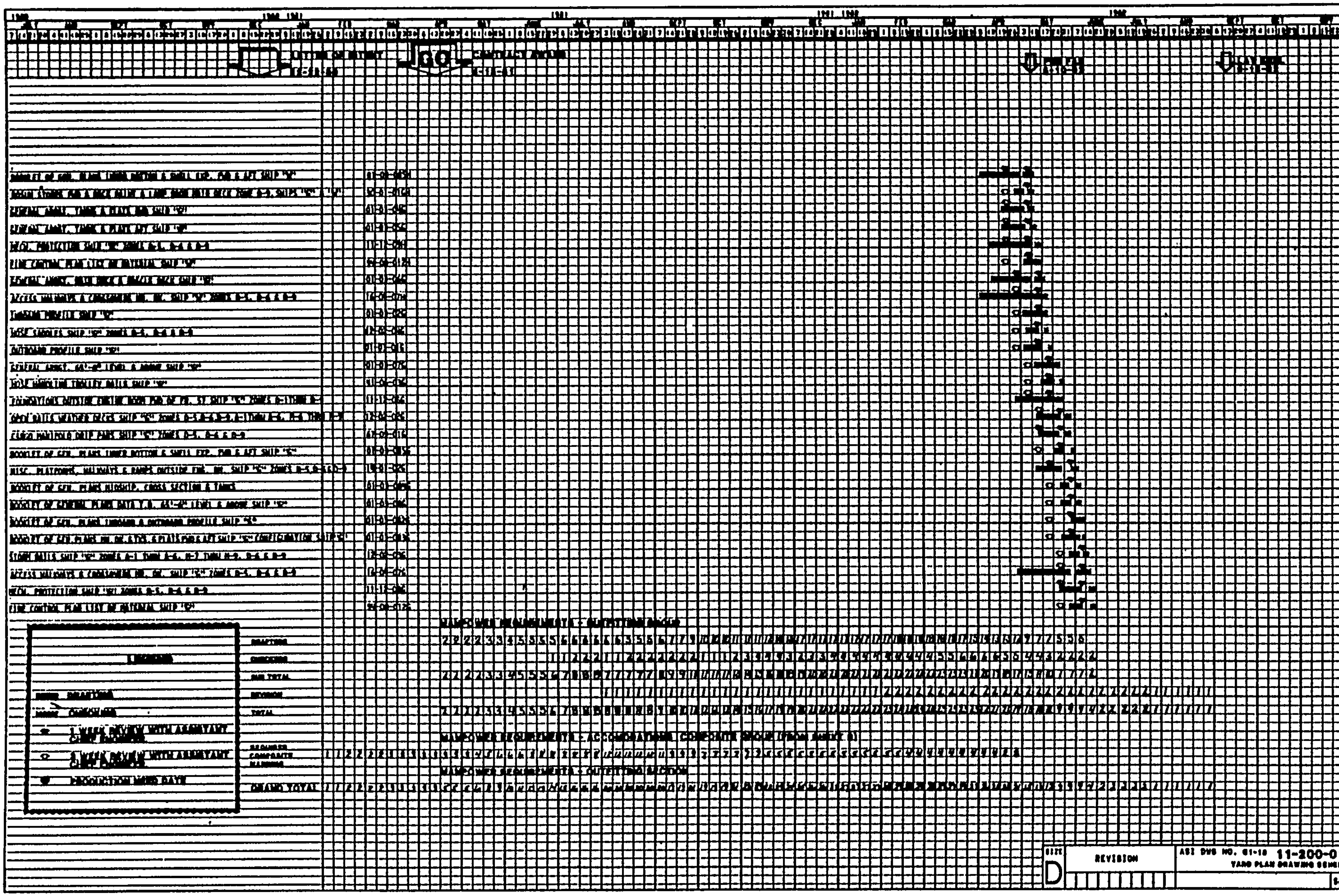


LETTER OF INTENT
GO
CONTRACT AWARD
LEGEND
DRAFTING
CHECKING
2 WEEK REVIEW WITH ASSISTANT CHIEF ENGINEER
PRODUCTION NEED DATE
YARD PLAN STAGE
CARGO, BALLAST & SLOP TANK ACCESS LADDERS SHIP
VERTICAL LADDERS OUTSIDE MACHY SPACES
GENERAL ARRGT. INNER BOTTOM SHIP
GENERAL ARRGT. TANK & FLATS FWD SHIP
INBOARD PROFILE SHIP
COMMISSARY ARRGT.
GENERAL ARRGT. TANK & FLATS AFT SHIP
BOOKLET OF GEN. PLANS INNER BOTTOM & SHELL EXP. FWD & AFT SHIP
ENGINEERS & ELECTRIC WORKSHOP & STORES AREAS
OUTBOARD PROFILE SHIP
GENERAL ARRGT. MAIN DECK & POOP DECK SHIP
FOUNDATIONS IN ENGINE ROOM
FOUNDATIONS IN COMMISSARY SPACES
COMMISSARY DETAILS
LAUNDRIES ARRGT. & DETS.
FOUNDATIONS IN ENGINE ROOM
SHIPS NAME & HAILING PORT, OWNER'S INSIGNIA & HULL MARKINGS
WALKWAYS, PLATFORMS & HANDRAILS IN ENGINE ROOM
EXPANDED METAL BOOKS & DOORS
WALKWAYS, PLATFORMS & HANDRAILS IN ENGINE ROOM
REVISION
SIZE D
ASI DWG NO. 11-200-01
YARD PLAN DRAWING SCHEDULE

EP-3



YARD PLAN STATUS
GO
REVISION
D
11-200-0



YARD PLAN STAGE
LETTER OF INTENT
CONTRACT AWARD
BOOKLET OF GEN. PLANS INNER BOTTOM & SHELL EXP. FWD & AFT SHIP "S"
BOOKLET OF GEN. PLANS MIDSHIP, CROSS SECTION & TANKS
BOOKLET OF GEN. PLANS INBOARD & OUTBOARD PROFILE SHIP "S"
STORM RAILS SHIP "S" ZONES A-1 THRU A-6, A-7 THRU A-9, B-6 & B-9
ACCESS WALKWAYS & CROSSOVERS MN. DK. SHIP "S" ZONES B-5, B-6 & B-9
FIRE CONTROL PLAN LIST OF MATERIAL SHIP "S"
MANPOWER REQUIREMENTS - OUTFITTING GROUP
MANPOWER REQUIREMENTS - ACCOMMODATIONS COMPOSITE GROUP (FROM SHEET 8)
MANPOWER REQUIREMENTS - OUTFITTING SECTION
DRAFTING
CHECKING
SUB TOTAL
REVISION
TOTAL
GRAND TOTAL
LEGEND
DRAFTING
CHECKING
1 WEEK REVIEW WITH ASSISTANT CHIEF ENGINEER
5 WEEK REVIEW WITH ASSISTANT CHIEF ENGINEER
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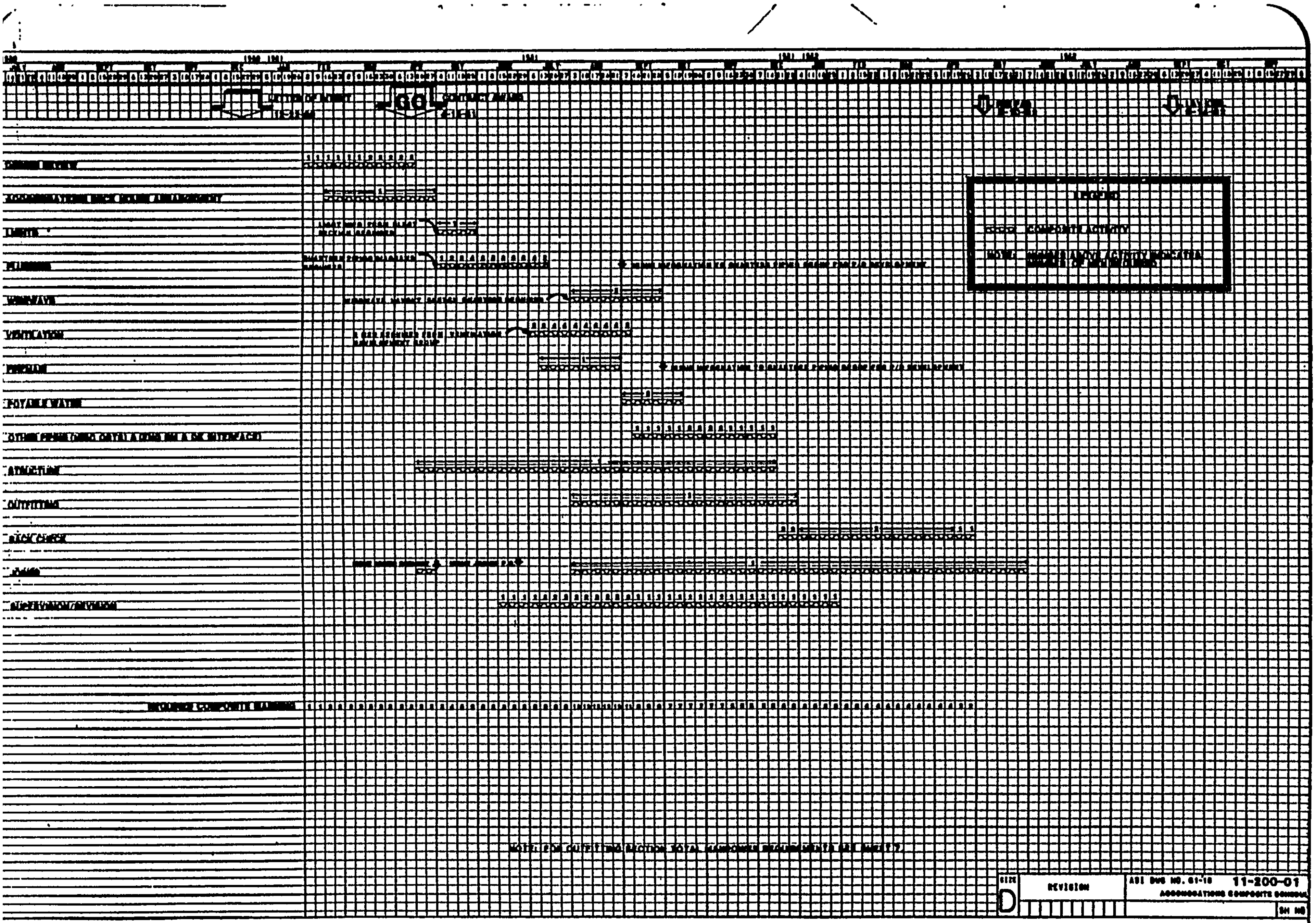
YARD PLAN DRAWING SCHEDULE

EP-5



LETTER OF INTENT
CONTRACT AWARD
DESIGN REVIEW
ACCOMMODATIONS DECK HOUSE ARRANGEMENT
LIGHTS
PLUMBING
WIREWAYS
VENTILATION
POTABLE WATER
STRUCTURE
OUTFITTING
BACK CHECK
SUPERVISION/DIVISION
LEGEND
COMPOSITE ACTIVITY
SIZE
D
REVISION
ASI DWG NO. 61-16
11-200-01
ACCOMMODATIONS COMPOSITE SCHEDULE
SH NO

REFERENCES

REV	NO	TITLE	DRAWING NO

HULL SECTION - DRAWING SCHEDULE

ASI DWG NO C1-15 11-100-01 REV 0

INDEX

SH NO	TITLE
1	TITLE BLOCK, PRINT DISTRIBUTION, INDEX AND REFERENCES
2	REVISION AND GENERAL NOTES
3	DRAWING SCHEDULE
4	DRAWING SCHEDULE
5	DRAWING SCHEDULE
6	DRAWING SCHEDULE

DISTRIBUTION

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MOLD LOFT					
PLANT ENGR & MAINT					
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PROGRAM MANAGER					1
QUALITY CONTROL					
ELECTRICAL					
ENGR STANDARDS					
FILES & RECORDS					
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HULL COMPOSITE					
DESIGN					
OUTFITTING					
STL TAKE OFF					
PIPING & HVAC					
MATERIAL REQN					
MECHANICAL DESIGN					
MECH COMPOSITE					
ENGR PLAN & SCHED	1	1	1	1	5
BAYOU BLACK					
HARVEY					
SERVICE FOUNDRY					
JOINER CONTRACTOR					
ADMEASURER					
MARAD (WASH)					
MARAD (YARD)					
OWNER (HOME)					
OWNER (YARD)					
ABS (NY)					
ABS (NO)					
ABS (YARD)					
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DATE OF ISSUE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NO	DESCRIPTION
1.	PRODUCTION NEED DATES RESERVED PENDING DETERMINATION BY PRODUCTION PLANNING.

RESERVATIONS

RECORD INFO

DEV. BY ENGINEERING PLANNING AND SCHEDULING

ASI HULL NO	NAME OF VESSEL
2337	
2336	
2333	

AVONDALE SHIPYARDS INC
P O BOX 50280
NEW ORLEANS, LA 70150

ASI JOB NO **C1-15**

EXXON COMPANY, USA

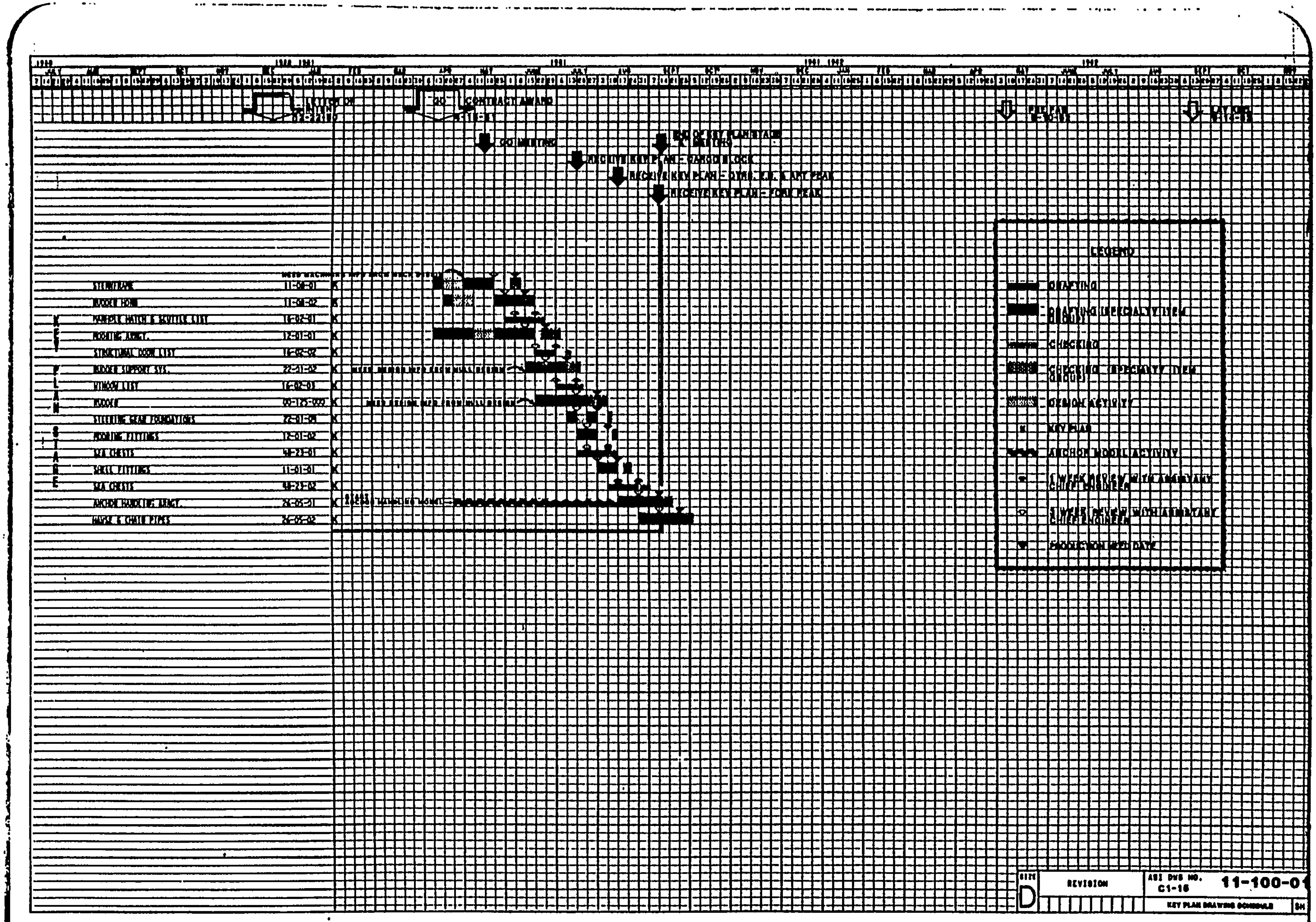
42,000 DWT MULTI-PRODUCTS CARRIERS

HULL SECTION
DRAWING SCHEDULE

DRAWN BY L M C DATE 4-24-81
CHECKED BY P D DATE 4-28-81
APVD [illegible] 5-4-81
[illegible] 6-1-81
APVD [illegible] 6/4/81 ASST CHIEF ENGINEER
APVD R. O. Abholen 6/4/81 PROGRAM MANAGER

SIZE D ASI DRAWING NO C1-15 11-100-01 REV 0
SCALE
SH NO 1 OF 7

EP-7


1981
CONTRACT AWARD
GO MEETING
END OF KEY PLAN STAGE
RECEIVE KEY PLAN - CARGO BLOCK
RECEIVE KEY PLAN - FORE PEAK
KEY PLAN STAGE
STERNFRAME 11-08-01 K
RUDDER HORN 11-08-02 K
MANHOLE HATCH & SCUTTLE LIST 16-02-01 K
MOORING ARRGT. 12-01-01 K
STRUCTURAL DOOR LIST 16-02-02 K
RUDDER SUPPORT SYS. 22-01-02 K
WINDOW LIST 16-02-03 K
RUDDER K
STEERING GEAR FOUNDATIONS K
MOORING FITTINGS 12-01-02 K
SEA CHESTS 48-23-01 K
SHELL FITTINGS 11-01-01 K
SEA CHESTS 48-23-02 K
ANCHOR HANDLING ARRGT. 26-05-01 K
HAWSE & CHAIN PIPES 26-05-02 K
LEGEND
DRAFTING
DRAFTING (SPECIALTY ITEM GROUP)
CHECKING
CHECKING (SPECIALTY ITEM GROUP)
DESIGN ACTIVITY
KEY PLAN
ANCHOR MODEL ACTIVITY
PRODUCTION NEED DATE
SIZE D
REVISION
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11-100-0
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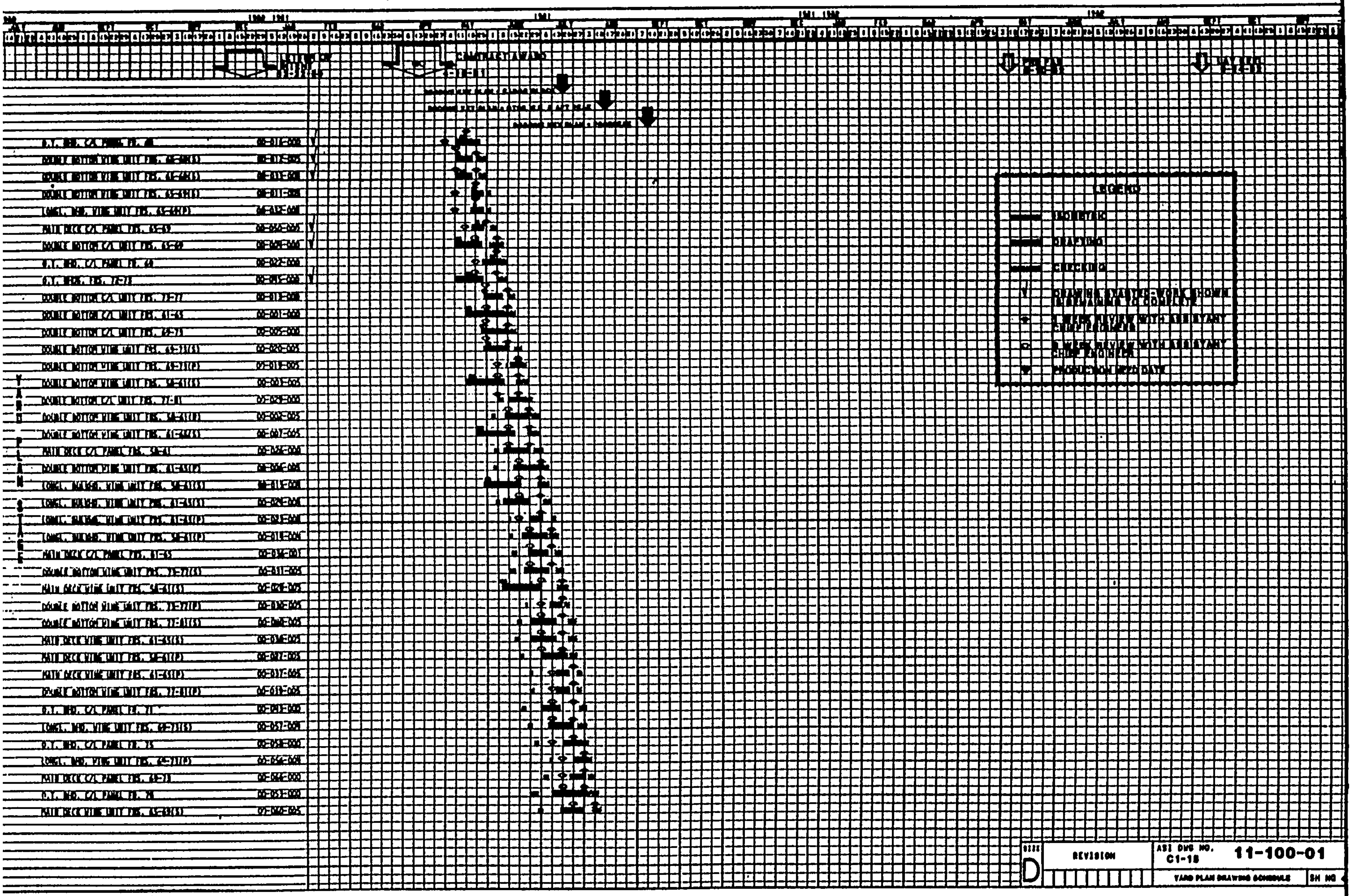
SH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CHECKING
REVISION
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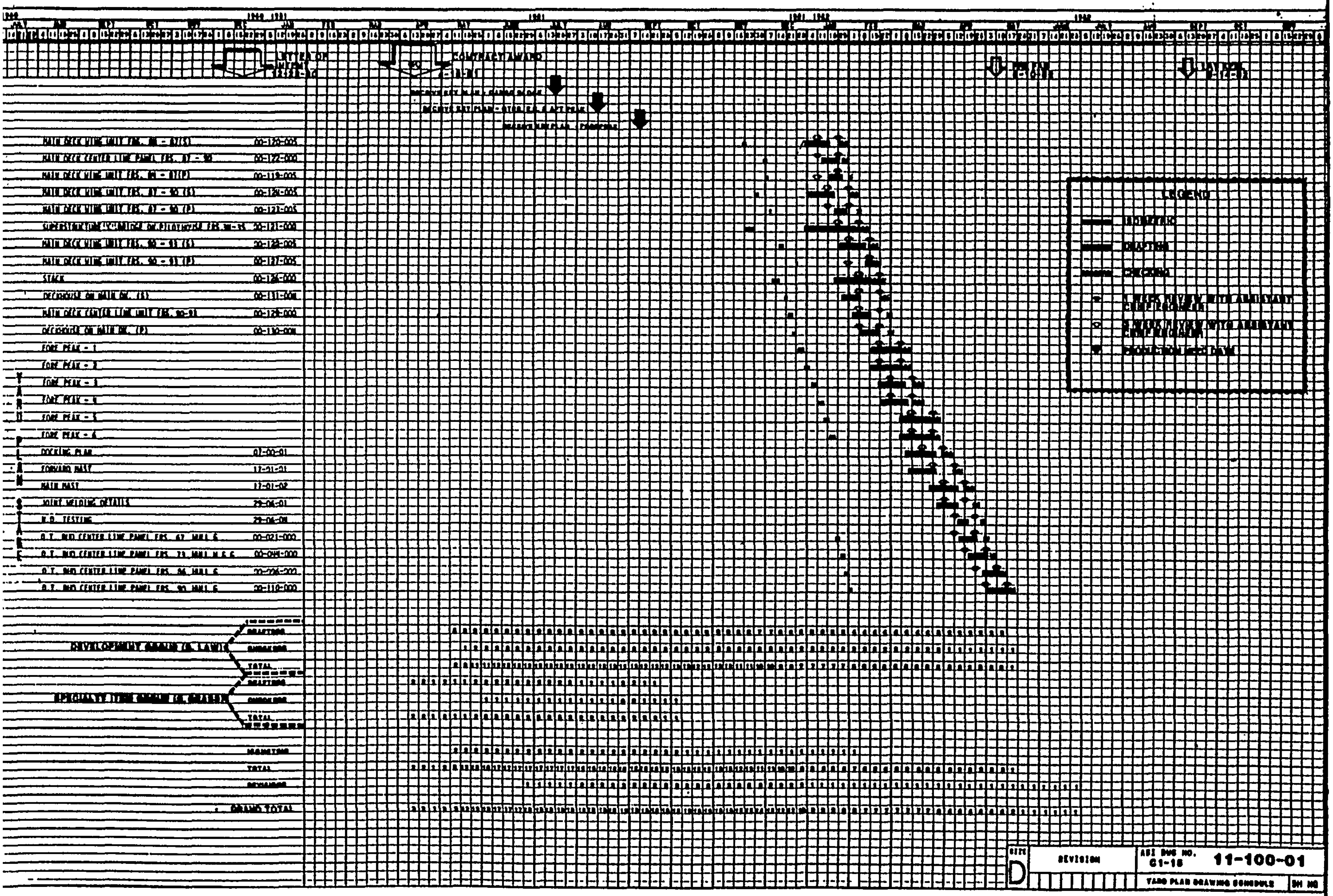
ASI DWG NO.
C1-18
11-100-01
YARD PLAN DRAWING SCHEDULE
SH NO

EP-9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LEGEND
DRAFTING
CHECKING
STACK 00-126-000
FORE PEAK - 1
FORE PEAK - 2
FORE PEAK - 3
FORE PEAK - 4
FORE PEAK - 5
FORE PEAK - 6
DOCKING PLAN 07-00-01
FORWARD MAST 17-01-01
MAIN MAST 17-01-02
JOINT WELDING DETAILS 29-06-01
N.D. TESTING 29-06-08
YARD PLANS
GRAND TOTAL
SIZE D
REVISION
ABS DWG NO. C1-15
11-100-01
YARD PLAN DRAWING SCHEDULE
SH NO

REFERENCES

REV	NO	TITLE	DRAWING NO

PIPING & HVAC SECTION
PIPING DEVELOPMENT & MACHINERY COMPOSITE GROUPS DRAWING SCHEDULE

A S I DWG NO C1-15 11-430-01 REV 0

INDEX

SH NO	TITLE
1	TITLE BLOCK, PRINT DISTRIBUTION, INDEX AND REFERENCES
2	REVISIONS AND GENERAL NOTES
3	KEY PLAN DRAWING SCHEDULE (ENGL. STRG.)
4	YARD PLAN DRAWING SCHEDULE (ENGL. STRG.)
5	YARD PLAN DRAWING SCHEDULE (ENGL. STRG.)
6	YARD PLAN DRAWING SCHEDULE (ENGL. STRG.)
7	YARD PLAN DRAWING SCHEDULE (ENGL. STRG.)
8	YARD PLAN DRAWING SCHEDULE (ENGL. STRG.)
9	QUARTERS PIPING DEVELOPMENT SCHEDULE
10	MAIN DECK COMPOSITE SCHEDULE
11	MACHINERY SPACE COMPOSITE SCHEDULE
12	MANPOWER SUMMARY SHEET

DISTRIBUTION

DEPARTMENT	REVISION
PRODUCTION	
PROD PLANNING	
MOLD LOFT	
PLANT ENGR & MAINT	
ESTIMATING	
PROGRAM MANAGER	
QUALITY CONTROL	
ELECTRICAL	
ENGR STANDARDS	
FILES & RECORDS	
HULL	
HULL COMPOSITE	
DESIGN	
OUTFITTING	
MTL TAKE OFF	
PIPING & HVAC	
MATERIAL REQN	
MECHANICAL DESIGN	
MECH COMPOSITE	
ENGR PLAN & SCHED	
BAYOU BLACK	
HARVEY	
SERVICE FOUNDRY	
JOINER CONTRACTOR	
ADMEASURER	
MARAD (WASH)	
MARAD (YARD)	
OWNER (HOME)	
OWNER (YARD)	
ABS (NY)	
ABS (NO)	
ABS (YARD)	
USCG (NO)	
USCG (YARD)	
LEGAL	
TOTAL	
PARTIAL ISSUE	
DATE OF ISSUE	

RESERVATIONS

NO	DESCRIPTION
2.	DRAWING NUMBERS FOR L/H'S, P/D'S & H/L'S TO BE ADDED ON REVISION 1.
1	PRODUCTION NEED DATES RESERVED PENDING DETERMINATION BY PRODUCTION PLANNING.

RECORD INFO

DEV. BY ENGINEERING PLANNING AND SCHEDULING

ASI HULL NO	NAME OF VESSEL
2237	
2236	
2235	

AVONDALE SHIPYARDS INC
P O BOX 50280
NEW ORLEANS, LA 70150

ASI JOB NO **C1-15**

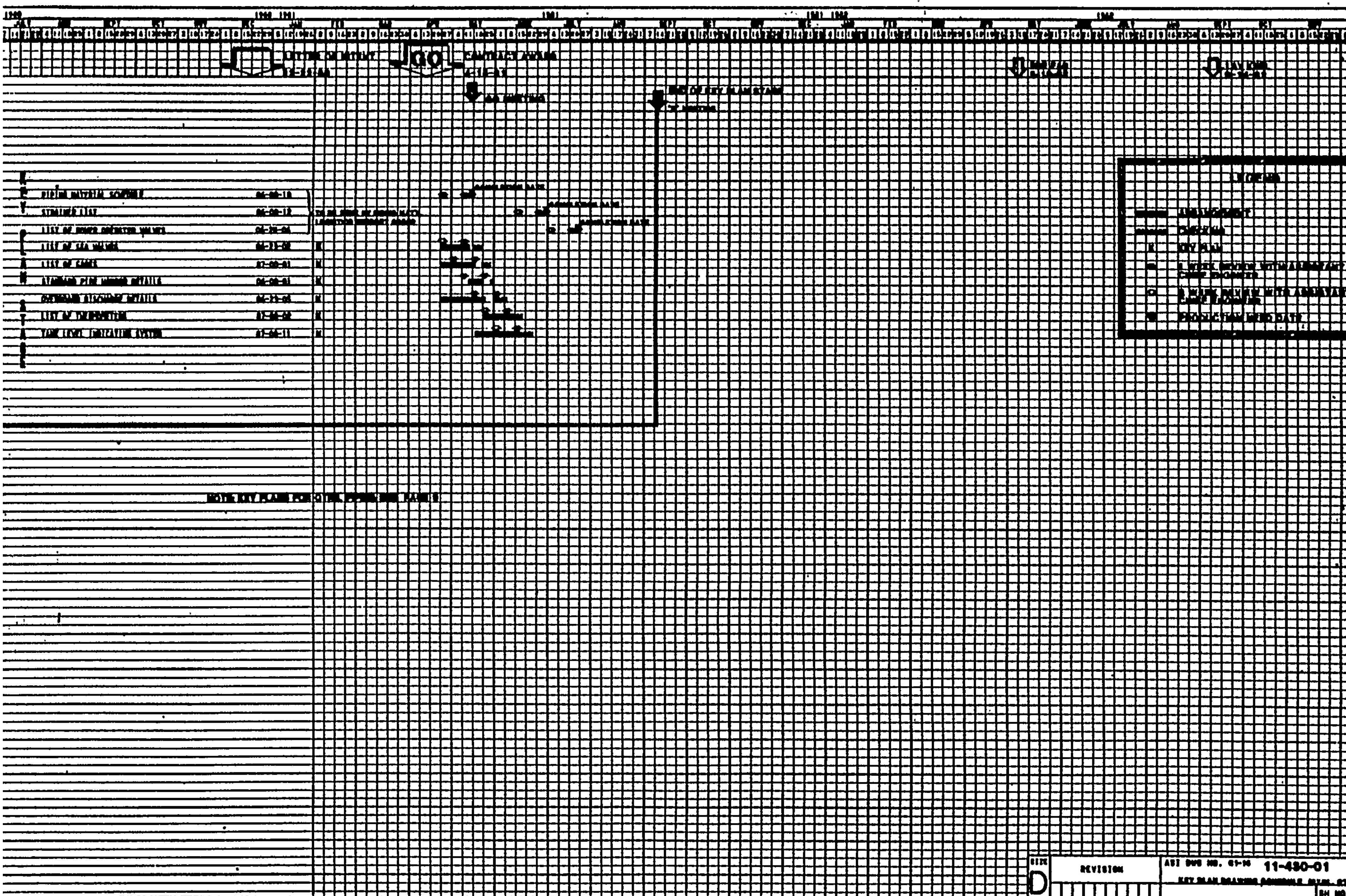
EXXON COMPANY, USA

42,000 DWT MULTI-PRODUCTS CARRIERS
PIPING & HVAC SECTION
PIPING DEVELOPMENT & MACHINERY COMPOSITE GROUPS DRAWING SCHEDULE

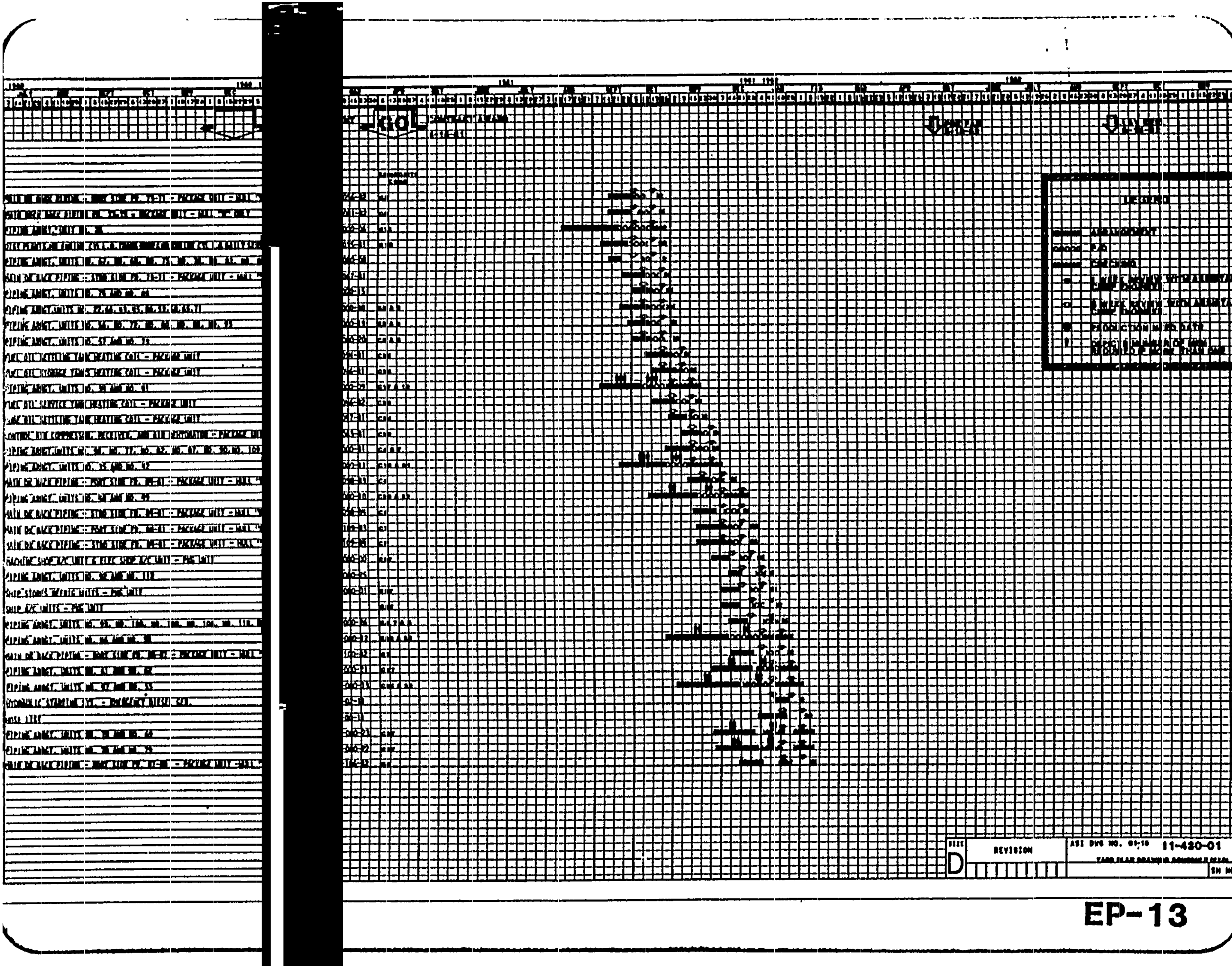
DRAWN BY	DATE
P.D./L.M.C.	5-5-81
CHECKED BY	DATE
J.J.O.	5-5-81
APVD	5-6-81
	5-6-81
APVD ASST CHIEF ENGINEER	5-6-81
APVD PROGRAM MANAGER	

SIZE D | ASI DRAWING NO C1-15 11-430-01 | REV 0

SCALE | SH NO 1 OF 12



LETTER OF INTENT
GO
CONTRACT AWARD
END OF KEY PLAN STAGE
PIPING MATERIAL SCHEDULE 06-08-10
STRAINER LIST 06-08-12
LIST OF POWER OPERATED VALVES 06-20-04
LIST OF SEA VALVES 06-23-08
LIST OF GAGES 07-08-01
STANDARD PIPE HANGER DETAILS 06-08-01
OVERBOARD DISCHARGE DETAILS 06-23-05
LIST OF THERMOMETERS 07-08-02
TANK LEVEL INDICATING SYSTEM 07-08-11
LEGEND
ARRANGEMENT
CHECKING
KEY PLAN
PRODUCTION NEED DATE
SIZE D
REVISION
ASI DWG NO.
11-430-01
SH NO



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SIZE
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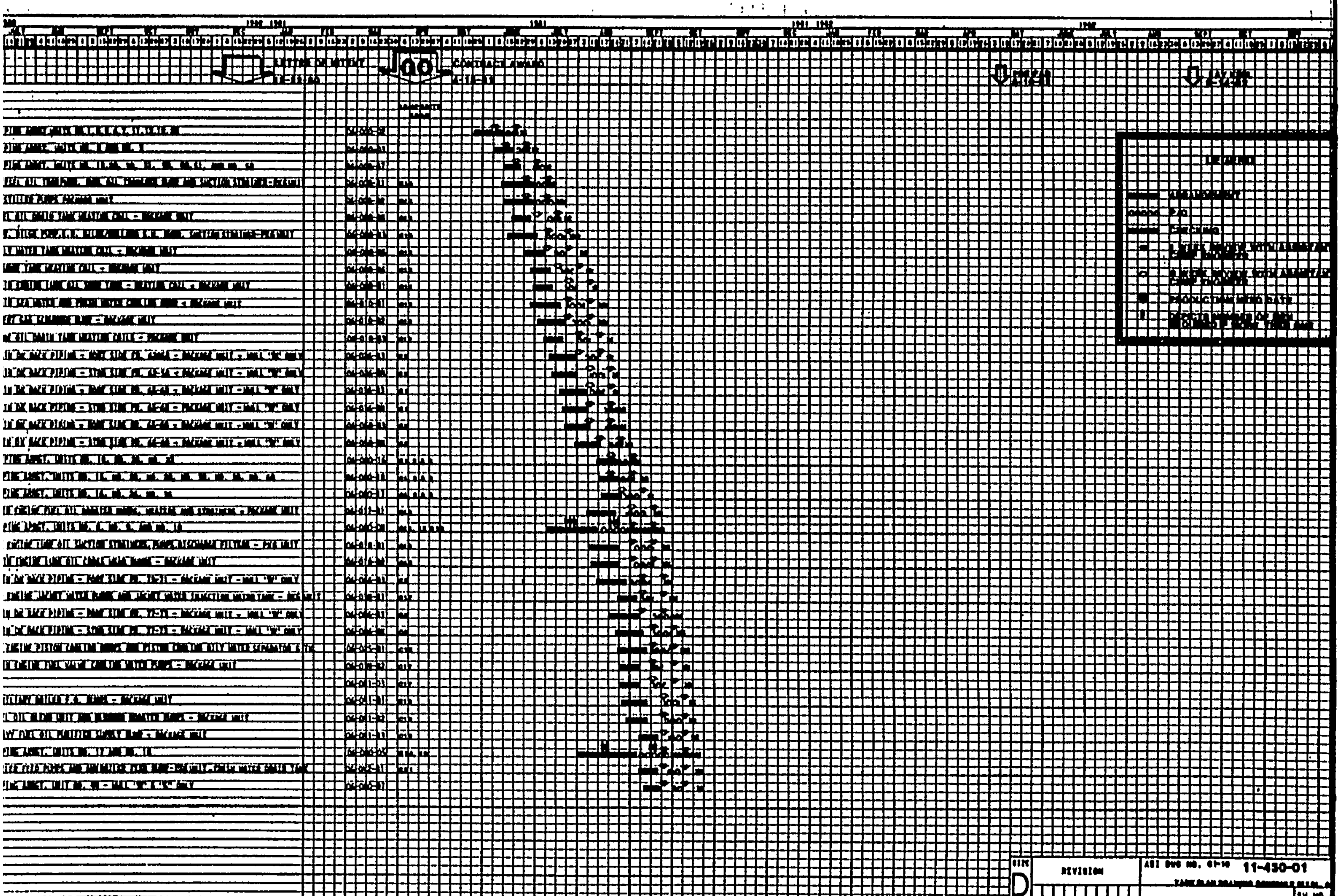
11-430-01

EP-13


LETTER OF INTENT
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CONTRACT AWARD
LEGEND
ARRANGEMENT
P/O
CHECKING
PRODUCTION MEMO DATE
SIZE
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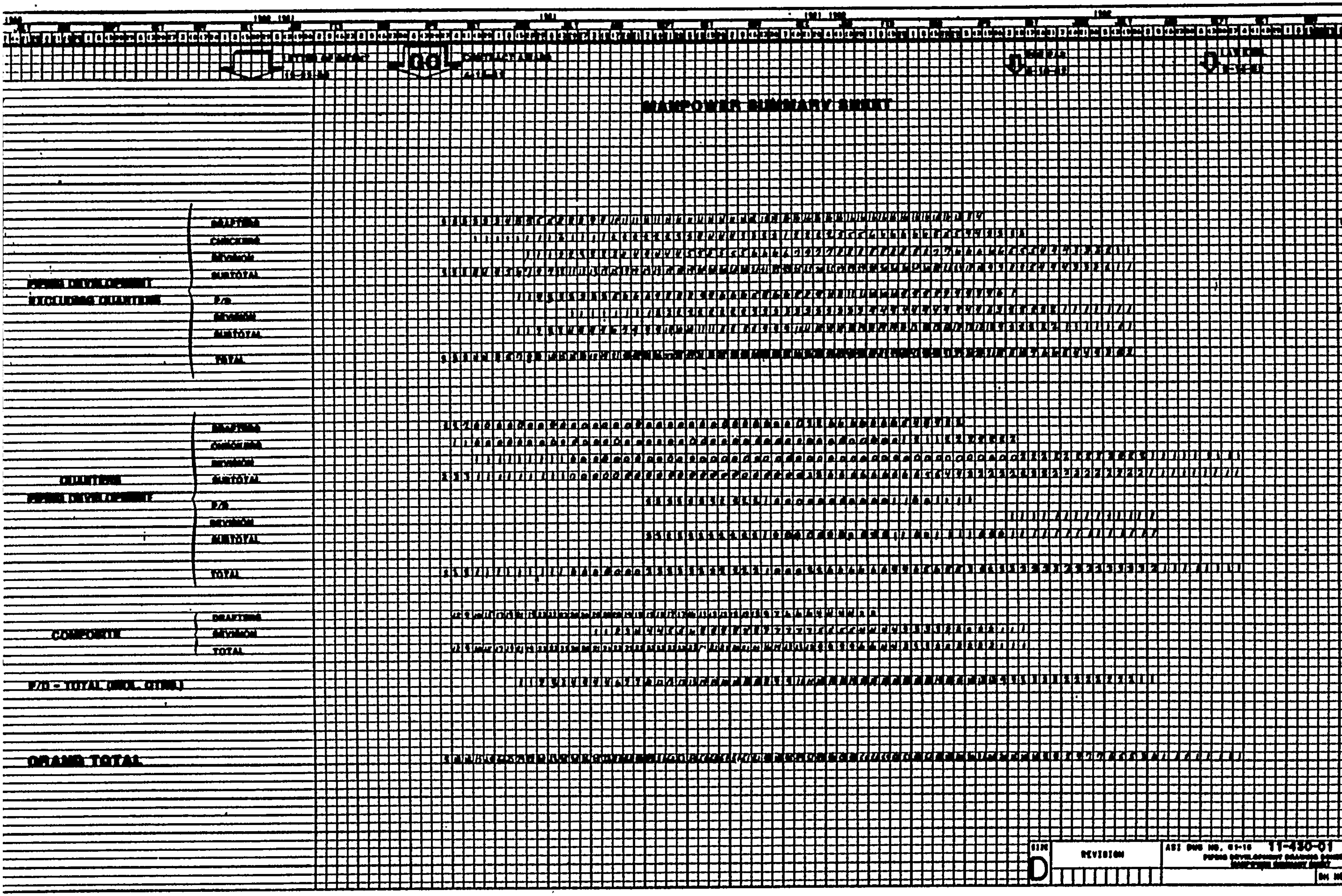
REVISION
11-430-01
SH NO


MANPOWER SUMMARY SHEET
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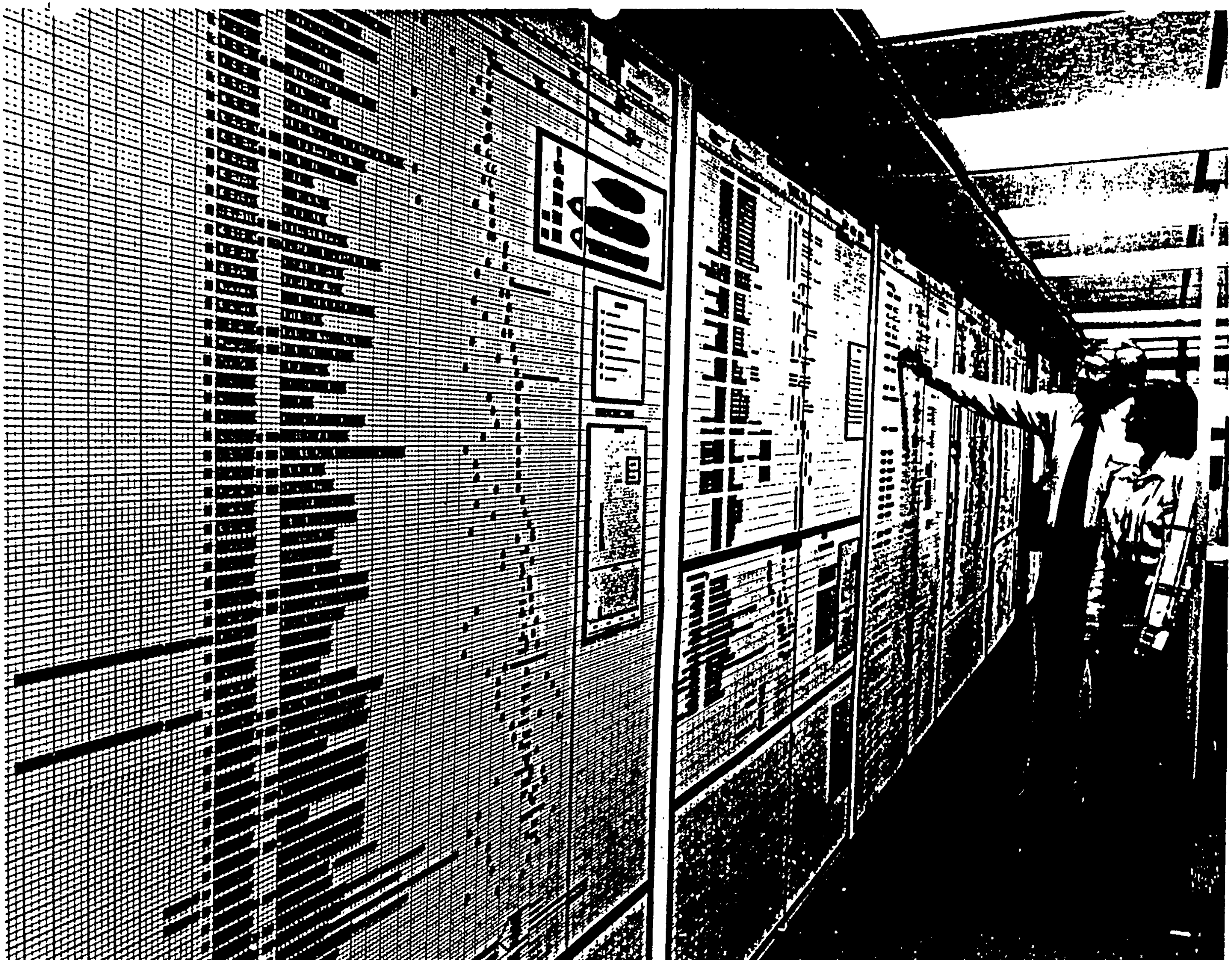
CHECKING
REVISION
SUBTOTAL
P/D
REVISION
SUBTOTAL
TOTAL
DRAFTING
CHECKING
REVISION
SUBTOTAL
P/D
REVISION
SUBTOTAL
TOTAL
DRAFTING
REVISION
TOTAL
GRAND TOTAL
SIZE
D
REVISION
ASI DWG NO. 81-15 11-430-01



08050

SCHEDULE REVIEW REPORT
SCHED# C10015-02 OUTFITTING EXXON

WEEK ENDING 6/28/81

DRAWING	ITEM	WEEKLY HRS. HRS. B/4 INITIAL ISSUE	EQUIV. MANDAYS	WEEKLY O.T. B/4 INITIAL ISSUE	EQUIV. O.T. MANDAYS	WEEKLY HRS. AFTER INITIAL ISSUE	EQUIV. MANDAYS	WEEKLY O.T. HRS. AFTER INITIAL ISSUE	EQUIV. O.T. MANDAYS
12 0511	01	9.3	1.16						
16 0201	01	2.0	.25						
16 0203	01	11.0	1.37						
16 0402B	01	23.5	2.93						
16 0403	01	15.7	1.96						
19 0101	01	40.0	5.00						
34 0101	01	22.0	2.75						
91 0101	01	8.9	1.11						

	WEEKLY HRS. HRS. B/4 INITIAL ISSUE	EQUIV. MANWEEKS	WEEKLY O.T. B/4 INITIAL ISSUE	EQUIV. O.T. MANWEEKS	WEEKLY HRS. AFTER INITIAL ISSUE	EQUIV. MANWEEKS	WEEKLY O.T. HRS. AFTER INITIAL ISSUE	EQUIV. O.T. MANWEEKS
TOTALS	132.4	3.31						

TOTAL # OF DRAWINGS 8

TOTAL # OF DRAWINGS WITH NO HOURS SPENT 0

EP-17

08050

SCHEDULE REVIEW REPORT
SCHED# C10015-022 OUTFITTING COST CODES EXXON

WEEK ENDING 6/28/81

DRAWING	ITEM	WEEKLY HRS. HRS. B/4 INITIAL ISSUE	EQUIV. MANDAYS	WEEKLY O.T. B/4 INITIAL ISSUE	EQUIV. O.T. MANDAYS	WEEKLY HRS. AFTER INITIAL ISSUE	EQUIV. MANDAYS	WEEKLY O.T. HRS. AFTER INITIAL ISSUE	EQUIV. O.T. MANDAYS
100000	02	60.0	7.50						
100000	03	11.2	1.40						
100000	09	119.8	14.97	4.7	.58				
100000	10	8.0	1.00						
100000	13	32.0	4.00						
100000	14	16.0	2.00						
100000	16	87.9	10.98						
100000	18	89.9	11.23						
100000	19	8.0	1.00						

	WEEKLY HRS. HRS. B/4 INITIAL ISSUE	EQUIV. MANWEEKS	WEEKLY O.T. B/4 INITIAL ISSUE	EQUIV. O.T. MANWEEKS	WEEKLY HRS. AFTER INITIAL ISSUE	EQUIV.	WEEKLY O.T. HRS. AFTER	EQUIV. O.T. MANWEEKS
TOTALS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TOTAL # OF DRAWINGS [illegible]

TOTAL # OF DRAWINGS [illegible]

EP-18

ASI JOB NO. C1-15 EXXON MULTI-PRODUCT CARRIERS
OUTFITTING SECTION - DRAWING GROUP
WEEKLY SCHEDULE REVIEW REPORT - DATE OF REVIEW 02-02-82

DISTRIBUTION: Dr. J. Wilkins
Mr. C. Morris
Mr. T. Doussan
Mr. A. Nierenberg
Mr. R. Ekholm
Mr. B. Griffin
Mr. K. Ogawa

J. BUSCH
ENGINEERING PLANNING & SCHEDULING
02-03-82

* "SCHEDULE" Refers To The Internal Engineering Schedule
* "% SCH" Refers To Scheduled % Completion At Time Of Review
* "CURR DATE" Refers To Current Estimated Completion Date

TOTAL DRAWINGS	123
DRAWINGS SCHEDULED FOR SUBMITTAL	34
DRAWINGS ACTUALLY SUBMITTED	38
DRAWINGS SCHEDULED FOR ISSUE	1
DRAWINGS ACTUALLY ISSUED	3

DRAWINGS ISSUED SINCE LAST REPORT (01-21-82) 1
DRAWINGS SUBMITTED COMPLETE SINCE LAST REPORT (01-21-82) 3

DRAWINGS BEHIND SCHEDULE

ROG	DWG NUMBER	TITLE	MH EXPENDED SIN L RPT	MH EXPENDED CUM	ETC	EAC IS	EAC WAS	VAR	SCHEDULED COMP DATE	ND DATE	% SCH	% NOW	% PREV	CURR DATE
001	11-05-10	EXP MAT BHDS/DOORS (M-3/M-4)	111	159	21	180	180	0	01-14-82	05-17-82	100%	98%	30%	02-08-82
002	16-04-07	TYP DETS OUT ITEMS MN DK RACKS	32	276	69	345	345	0	02-05-82	03-22-82	90%	88%	77%	
003	16-04-054	WKWAYS/PLAT/HRLS ENG ROOM (M-4)	0	0	200	200	200	0	03-01-82	08-09-82	18%	0%	0%	
004	16-04-05	WKWAYS/PLAT/HRLS ENG RM (M-1)	44	44	756	800	800	0	03-12-82	05-15-82	52%	6%	10%	
005	40-00-02	MCHY ARRGT (S/E) (M-1 TO M-8)	0	0	337	337	337	0	03-18-82	05-31-82	22%	0%	0%	
006	40-00-01	MCHY ARRGT (M-1 TO M-8)	37	37	323	360	360	0	03-19-82	04-19-82	13%	11%	0%	
007	41-06-04	MISC LIFT GEAR (M-1 TO M-8)	0	0	400	400	400	0	03-22-82	05-03-82	20%	0%	0%	
008	31-02-02	MISC STOWAGE (M)	0	108	392	500	500	0	03-26-82	05-03-82	30%	24%	24%	
009	11-12-05	FNDNS OUT ENG RM AFT 57	80	91	809	900	900	0	04-22-82	08-09-82	44%	11%	1%	04-22-82

DRAWINGS SUBMITTED INCOMPLETE

ROG	DWG NUMBER	TITLE	MH EXPENDED SIN L RPT	MH EXPENDED CUM	ETC	EAC IS	EAC WAS	VAR	SCHEDULED COMP DATE	ND DATE	% SCH	% NOW	% PREV	CURR DATE
001	16-02-01B	MNHOLE HTCH/SCUT LIST	6	259	41	300	300	0	07-10-81	03-22-82	100%	94%	94%	05-28-82
002	19-01-01	PNTG SCH	3	240	150	390	390	0	07-31-81	09-18-81	100%	95%	95%	07-01-82
003	16-02-01H	MNHOLE HTCH/SCUT LIST	10	54	12	66	66	0	08-28-81	06-14-82	100%	91%	91%	04-16-82
004	94-00-01BH	FIRE CONTRL PLAN	0	308	44	352	352	0	09-11-81	12-06-82	100%	94%	94%	04-01-82
005	16-04-03	EXT ACC LDR/PLT HSE/CAS/STK	25	459	9	468	468	0	09-18-81	04-05-82	100%	86%	86%	04-26-82
006	01-03-03	GNRL ARRGT INTBM	0	110	3	113	113	0	09-18-81	05-17-82	100%	95%	95%	06-25-82
007	01-03-02BH	INBOARD PROFILE	0	156	17	173	173	0	10-01-81	07-14-82	100%	92%	92%	04-30-82

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DRAWINGS SUBMITTED INCOMPLETE — CONT'D

DWG NUMBER	TITLE	MH EXPENDED SIN L RPT	CUM	ETC	EAC IS	WAS	VAR	SCHEDULED COMP DATE	ND DATE	% SCH	% NOW	% PREV	CURR DATE
~~01-03-05~~	~~GNRL ARRGT TKS/FLATS AFT~~	3	218	10	228	228	0	10-16-81	05-24-82	100%	99%	99%	05-03-82
16-02-04	EXP TRUNK BALL TRUNK ACC	0	190	14	204	204	0	10-23-81	06-07-82	100%	94%	94%	05-24-82
01-03-01B	OUTBOARD PROFILE	0	210	23	233	233	0	11-04-81	07-13-82	100%	97%	97%	04-30-82
01-03-07	GNRL ARRGT SER DK ABV/CASING ABV	3	189	11	200	200	0	11-13-81	08-23-82	100%	95%	95%	05-03-82
~~11-12-04~~	~~FNDNS ENGINE ROOM (M-1)~~	0	261	40	301	301	0	11-27-81	03-22-82	100%	95%	95%	03-12-82
11-12-07	FNDNS COMM SPACES	0	144	18	162	162	0	12-16-81	07-05-82	100%	95%	95%	05-03-82
01-03-084B	BOOK GEN PLS MID/C SECT/TK CONF	0	72	9	81	81	0	12-16-81	07-13-82	100%	96%	96%	05-14-82
14-01-01	DK COVERING SCH	10	178	50	228	206	+22	03-04-82	11-22-82	45%	91%	84%	07-01-82
~~94-00-012~~	~~MISC FR FT/SAF EQ INST~~	0	113	12	125	125	0	03-29-82	09-20-82	0%	98%	98%	02-15-82
30-01-01	BOSUN STORES/DK PAINT RM FWD	0	409	18	427	427	0	04-16-82	10-04-82	0%	91%	91%	04-16-82

DRAWINGS BEING WORKED ON OR AHEAD OF SCHEDULE

DWG NUMBER	TITLE	MN EXPENDED SIN L RPT	CUM	ETC	EAC IS	WAS	VAR	SCHEDULED COMP DATE	ND DATE	% SCH	% NOW	% PREV
16-04-072B	OUT ITEMS MN DK RACKS (D51,52)	106	509	125	634	560	+74	02-05-82	03-22-82	86%	88%	80%
30-01-02	HALON/CO2/FOAM ROOM	5	214	66	280	280	0	02-26-82	07-19-82	39%	85%	83%
30-01-04	02/A2 RM 65'- 6" LVL (25-30)	56	87	33	120	120	0	03-04-82	08-16-82	0%	81%	30%
11-12-042	FNDNS ENGINE ROOM (M-2)	48	301	259	560	560	0	03-05-82	05-03-82	39%	60%	0%
12-02-01BH	ATRM/GD RAILS MN/FCSL DKS	50	266	234	500	500	0	03-12-82	12-06-82	46%	59%	48%
16-04-073B	OUT ITMS MN DK (D-61,62,63,64)	72	547	215	762	700	+62	03-12-82	04-26-82	53%	78%	74%
94-00-01G	FIRE CONTRL PLAN	0	8	102	102	102	0	03-18-82	09-02-83	0%	8%	8%
16-04-04	INT ACC LDRS CAS/Stk (M-6,7,8)	36	40	240	280	280	0	03-18-82	05-24-82	0%	16%	0%
14-01-02B	MISC PLAT/WKW/RMP/LDR OMS	12	338	122	460	460	0	03-19-82	05-24-82	33%	82%	79%
12-05-04	MISC DAVITS (D-5,6,9)	0	17	203	220	220	0	03-19-82	05-10-82	0%	9%	9%
11-12-043	FNDNS ENGINE ROOM (M-3)	41	86	414	500	500	0	03-19-82	05-15-82	0%	19%	10%
16-04-08	INT ACC LDRS AFT 59 BLW MN DK	61	529	188	717	675	+42	03-19-82	03-22-82	81%	82%	77%
11-12-044	FNDNS ENGINE ROOM (M-4)	0	32	328	360	360	0	03-19-82	05-17-82	0%	10%	10%
48-03-08	FR STA CAB/RKS OMS A & D	16	16	104	120	120	0	03-19-82	07-05-82	0%	15%	0%
30-01-05	BTRY LCKRS A & D (A-5,7)	32	101	79	180	180	0	03-25-82	08-16-82	0%	62%	43%
41-06-02	MISC TROLLEY RAILS (A-1,M-7)	27	241	59	300	300	0	03-30-82	05-03-82	0%	89%	79%
16-04-056	WKWAYS/PLAT/HRLS ER/CAS (M-68)	22	22	378	400	400	0	04-01-82	08-09-82	4%	6%	0%
18-02-01	PRO COVERS (D-5,6,9,A-3)	26	26	19	45	45	0	04-02-82	05-16-82	0%	70%	0%
30-01-08	ENGR PAINT LKR AFT (M-5)	0	149	47	196	196	0	04-06-82	08-16-82	0%	83%	83%
30-01-06	MISC OUT ITEMS (D-5,6,9)	0	27	284	311	311	0	04-07-82	04-26-82	0%	10%	5%
82-01-01	LIFEBT HAND/INF RAFTS (A-2,3)	0	25	195	220	220	0	04-08-82	08-16-82	[illegible]	[illegible]	[illegible]

DRAWINGS BEING WORKED ON OR AHEAD OF SCHEDULE CONT'D

ROG	DWG NUMBER	TITLE	MH EXPENDED SIN L RPT	CUM	ETC	EAC IS	EAC WAS	VAR	SCHEDULED COMP DATE	ND DATE	% SCH	% NOW	% PREV
022	31-02-01	MISC STOWAGE (A/D)	0	9	291	300	300	0	04-08-82	05-03-82	0%	3%	3%
023	17-01-05	JACK/ENSIGN STAFFS	29	29	51	80	80	0	04-09-82	03-07-83	0%	40%	0%
024	12-05-11	STRS HST MONORL A & D	0	253	227	480	480	0	04-09-82	06-28-82	25%	58%	58%
025	14-01-04	MISC WOOD GRATINGS	8	8	112	120	120	0	04-13-82	11-22-82	0%	7%	0%
026	16-04-052	WKWAYS/PLAT/HRLS ENG RM (M-2)	0	64	236	300	300	0	04-16-82	06-28-82	0%	24%	24%
027	11-12-06B	FNDNS OUTSIDE ENGINE ROOM	0	62	338	400	400	0	04-16-82		0%	17%	17%
028	12-02-02	STRM/GD RAILS HSE/CASING (EXT)	81	81	179	260	260	0	04-16-82	08-16-82	0%	35%	0%
029	30-01-03	BTRWTH HOSE/DK GEAR STRMS	55	92	228	320	320	0	04-21-82	08-16-82	0%	32%	13%
030	16-02-01G	MNHOLE HTCH/SCUT LIST	7	7	33	40	40	0	04-30-82	09-27-82	0%	19%	0%
031	11-12-045	FNDNS ENGINE ROOM (M-5 TO M-8)	9	9	351	360	360	0	05-07-82	07-12-82	0%	3%	0%

NOTES

1 Vendor Info Req'd

2 "CURR DATE" To Be Supplied By B. J. Griffin @ Next Scheduled Review (2-16-82)

COMMENTS

41-06-01 Trolley Rails - Mn & Aux Diesel Engines - Completed

34-01-02 Commissary Details - Zone A-1 - Completed (5% Res'd)

16-02-052BH Hole List, Fr 58 Thru 93, Mn Dk & Below - Completed

16-02-054 Hole List, Aft 58, Hse, Casing & Stack Abv Mn Dk - Completed (1% Res'd)

Average required manpower for Subject Schedule For February is 23 men.
At Present there are 17 Equivalent men on subject schedule.

IN ADDITION TO THE PROJECTION INCREASES INDICATED ABOVE, ESTIMATES AT COMPLETION WERE ALSO INCREASED FOR THE FOLLOWING DRAWINGS:

DWG. NO.	FROM	TO	VARIANCE
16-04-02BH	1130	1140	10
01-03-04BH	223	229	6
16-02-052BH	90	92	2
16-02-054	45	64	19

EP-21

MECHANICAL DESIGN SECTION
MATERIAL PROCUREMENT SCHEDULE

REFERENCES

REV	NO	TITLE	DRAWING NO

INDEX

SH NO	TITLE
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DISTRIBUTION

DEPARTMENT	[illegible]	[illegible]	[illegible]	REVISION 0
PRODUCTION				
PROD PLANNING				
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ESTIMATING				
PROGRAM MANAGER				1
QUALITY CONTROL				
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ENGR STANDARDS				
FILES & RECORDS				
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HULL COMPONENTS				
DESIGN				
OUTFITTING				
MTL TAKE OFF				
H V A C				
MATERIAL [illegible]				1
MECHANICAL	1	1	1	1
MECH COMPONENTS				
ENGR PLAN & SCHED	5	5	5	5
BAYOU BLACK				
HARVEY				
SERVICE FOUNDRY				
JONAS CONTRACTOR				
ADMIRALS				
MARAD (WASH)				
MARAD (YARD)				
OWNER (HOME)				
OWNER (YARD)				
ABS (NY)				
ABS (NO)				
ABS (YARD)				
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MATERIAL CONTROL				1
LEGAL				1
TOTAL	6	6	6	11
PARTIAL ISSUE				
DATE OF ISSUE	[illegible]	[illegible]	[illegible]	[illegible]

RESERVATIONS

NO	DESCRIPTION
1.	VARIOUS [illegible] NEED DATES RESERVED PENDING RECEIPT OF INFORMATION FROM [illegible].

RECORD INFO

DEV. BY ENGINEERING PLANNING AND SCHEDULING

2337	
2336	
2318	
ASI HULL NO	NAME OF VESSEL

AVONDALE SHIPYARDS INC
P O BOX 50280
NEW ORLEANS, LA
70150

ASI JOB NO **C1-15**

EXXON COMPANY, USA

42,000 DWT MULTI-PRODUCTS CARRIERS

MECHANICAL DESIGN SECTION

MATERIAL PROCUREMENT SCHEDULE

DRAWN BY R.J.A. DATE 6/25/81
CHECKED BY P.D. DATE 6/25/81
APVD [illegible] 6/26/81
APVD A. [illegible] 6/30/81 ASST CHIEF ENGINEER
APVD [illegible] 7/10/81 PROGRAM MANAGER

SIZE D | ASI DRAWING NO C1-15 11-500-02 | REV 0

SCALE | SH NO 1 OF 10

ASI DWG NO C1-15 11-500-02 REV 0

8	7	6	5	4	3	2	1

REVISIONS

REV	SH	ZONE	DESCRIPTION

REVISIONS

REV	SH	ZONE	DESCRIPTION

GENERAL NOTES

LETTER OF INTENT	12-22-80	CONTRACT AWARD	4-15-81

ASI HULL NO.	PRE FAB	LAY KEEL	LAUNCH	DELIVERY
2335	8-10-82	9-14-82	5-14-83	10-15-83
2336	9-2-82	12-7-82	8-6-83	1-7-84
2337	10-25-82	3-1-83	10-28-83	3-31-84

LEGEND

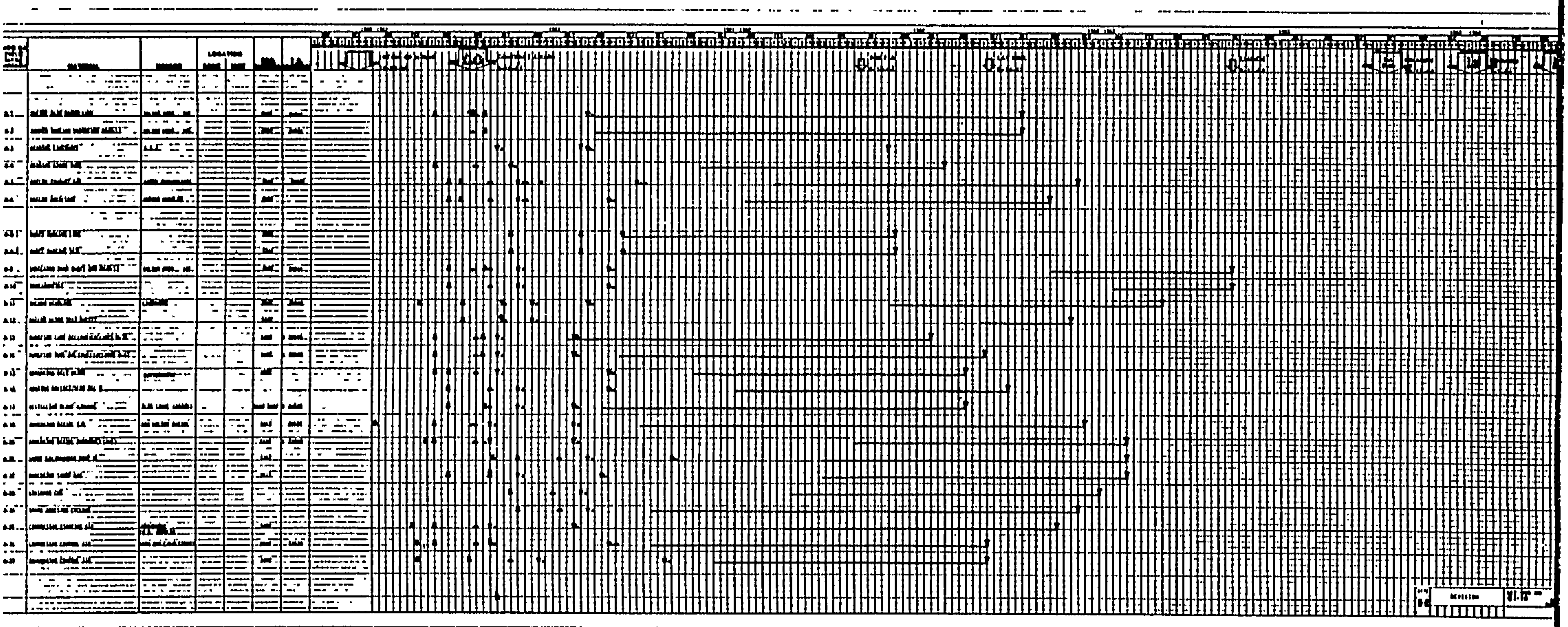
- SCHEDULED MATERIAL REQUISITION ISSUE DATE
- ACTUAL MATERIAL REQUISITION ISSUE DATE
- SCHEDULED PURCHASE ORDER ISSUE DATE
- ACTUAL PURCHASE ORDER ISSUE DATE
- ▽ VENDOR PRELIMINARY INFORMATION NEED DATE, LETTER INDICATES SECTION
- ▼ VENDOR DETAILED INFORMATION NEED DATE LETTER INDICATES SECTION
- VENDOR MANUFACTURING LEAD TIME
- PRODUCTION NEED DATE
- SCHEDULED DRAWING SUBMITTAL DATE
- V THE LETTER V NEXT TO PURCHASE ORDER NUMBER NOTES VERBAL PURCHASE ORDER

1. SCHEDULE TO BE MONITORED WEEKLY THROUGH MATERIAL PROCUREMENT SCHEDULE REVIEW PRINT OUT PREPARED BY ENGINEERING PLANNING AND SCHEDULING. TROUBLE AREAS NEEDING ACTION WILL BE INDICATED ON THIS PRINT OUT.

2. SCHEDULE TO BE UPDATED PERIODICALLY TO INDICATE ACTUAL REQUISITIONS, PURCHASE ORDERS AND VENDORS AND TO INCORPORATE M.O.G. CHANGES. ACTUAL RECEIPT OF PRELIMINARY & DETAILED VENDOR INFORMATION TO BE INDICATED ON "MATERIAL PROCUREMENT SCHEDULE REVIEW PRINT OUT" ONLY.

SIZE	REVISION	AS DWG NO	
D		C1-15	11-500-02 REVISIONS AND GENERAL NOTES
			SH NO 2 OF 1

8	7	6	5	4	3	2	1



ASI JOB NO. C1-15 EXXON MULTI-PRODUCT CARRIERS
MECHANICAL DESIGN SECTION 11-500-02
MATERIAL PROCUREMENT SCHEDULE REVIEW REPORT
DATE OF REVIEW 6-15-81

J. BUSCH
ENGINEERING PLANNING & SCHEDULING
6-24-81

*	Trouble Area-Action Required
VI	Vendor Information
VPO	Verbal Purchase Order
NYA	Not Yet Available
N/R	Not Required

DISTRIBUTION: R. Meric
C. Morris
T. Doussan
W. Potts
~~A. Nierenberg~~
R. Ekholm
T. Poole/J. Falanga
A. Navarre

ROG	MOG NUMBER	MATERIAL	SCH REQ	ACT REQ	REQ NO	SCH P O	ACT P O	P O NO	SCH V I PREL	ACT V I PREL	SCH V I DET	ACT V I DI
0001	M-1	Engine Main Propulsion	02-02-81	04-28-81	542F	03-16-81	04-15-81	EX 501	05-14-81	*	08-10-81	
0002	M-2	Damp Torsion Vibrat	NYA	04-28-81	542F	NYA	04-15-81	EX 501	NYA		NYA	
0003	M-3	Bearing Line Shaft	N/R	N/R	N/R	N/R	N/R	N/R	05-15-81	*	08-10-81	
0004	M-4	Bearing Stern Tube	03-16-81	*		04-27-81	*		05-25-81	*	N/R	N/R
0005	M-5	Boiler Exhaust Gas	03-23-81	04-03-81	530F	05-04-81	*		06-01-81	*	10-01-81	
0006	M-6	Boiler Auxiliary	03-23-81	04-03-81	529F	05-04-81	*		06-01-81	*	08-31-81	
0007	M-8-1	Shaft Forging Line	08-03-81	05-25-81	570F	09-14-81			N/R	N/R	N/R	N/R
0008	M-8-2	Shaft Forging Tail	08-03-81	05-25-81	570F	09-14-81			N/R	N/R	N/R	N/R
0009	M-9	Indicatr Prop Shft RPM	03-23-81	04-28-81	542F	05-04-81	04-15-81	EX 501	06-01-81	*	09-01-81	
0010	M-10	Torsion Meter	03-23-81	04-28-81	542F	05-04-81	*		06-01-81	*	09-01-81	
0011	M-11	Anchor Windlass	04-06-81	02-20-81	506F	05-18-81	05-14-81	EX 503	06-15-81	05/08/81	08-10-81	
0012	M-12	Boiler Wtr Test Outfit	04-06-81	05-13-81	560F	05-18-81	*		06-15-81	*	N/R	N/R
0013	M-13	Purifier Lube Oil	03-02-81	04-27-81	539F	04-13-81	VPO	EX 538	05-15-81	*	08-01-81	
0014	M-14	Purifier Fuel Oil	03-02-81	04-27-81	539F	04-13-81	VPO	EX 538	05-15-81	*	08-01-81	
0015	M-14-1	Pmp F.O. Purifier Sup.	NYA	04-27-81	539F	NYA	VPO	EX 538	NYA		NYA	
0016	M-15	Separator Oily Water	03-02-81	03-23-81	523F	04-13-81	*		05-15-81	*	09-01-81	
0017	M-16	Monitor Blst/Slop Oil	03-23-81	*		05-04-81	*		06-01-81	*	09-01-81	
0018	M-17	Distilling Plant W/Pump	03-23-81	04-28-81	543F	05-04-81	VPO	EX 537	06-01-81	*	08-01-81	
0019	M-19	Generator Diesel S/S	02-23-81	01-07-81	501F	04-06-81	04-15-81	EX 527	05-04-81	02-25-81	08-01-81	
0020	M-20	Generator Diesel Emerg	02-23-81	02-27-81	515F	04-06-81	VPO	EX 540	05-04-81	05-07-81	08-01-81	
0021	M-21	Inert Gas/Dehumid Cond	06-01-81	05-06-81	535F	07-13-81			08-15-81		11-01-81	
0022	M-22	Generator Inert Gas	03-23-81	05-04-81	541F	05-04-81	*		06-01-81	*	09-28-81	
0023	M-23	Stripper CO2	05-25-81	*		07-06-81			08-03-81		N/R	N/R
0024	M-24	Spark Aresstor Cyclone	06-01-81	*		07-13-81			08-15-81		N/R	N/R
0025	M-25	Compressor Startng Air	02-23-81	02-13-81	502F	04-06-81	*		05-04-81	*	08-01-81	
0026	M-26	Compressor Control Air	02-23-81	02-18-81	503F	04-06-81	05/07/81	EX 529	05-04-81	04-27-81	09-01-81	
0027	M-27	Dehydrator Control Air	04-13-81	02-18-81	504F	05-15-81	*		06-22-81	*	11-01-81	
0028	M-30	Tank D-G Jkt Wtr Exp	05-04-81	*		06-15-81	*		07-13-81		N/R	N/R
0029	M-31	Draft System	03-23-81	*		05-04-81	*		06-01-81	EP-25	12-01-81	

MOG NUMBER	MATERIAL	SCH REQ	ACT REQ	REQ NO	SCH P O	ACT P O	P O NO	SCH V I PREL	ACT V I PREL	SCH V I DET	ACT V I DET
M-85	Tank Mn Eng Cyl L.O.	N/R	N/R	N/R	N/R	N/R	N/R	06-15-81	*	10-01-81	
M-87	Tk Stern Lube L.O. Drn	N/R	N/R	N/R	N/R	N/R	N/R	05-15-81	*	10-01-81	
M-88	Tk Fwd Stern Tube L.O.	N/R	N/R	N/R	N/R	N/R	N/R	05-15-81	*	10-01-81	
M-92	Blst Mud Disp Sys	03-09-81	05-15-81	564F	04-20-81	*		05-04-81	*	N/R	N/R
M-93	Sodium Hypochl Sys	03-09-81	02-27-81	514F	04-20-81	04-30-81	EX 751	05-18-81	*	N/R	N/R
M-94	Cooler Mn Eng Jkt Wtr	03-09-81	02-26-81	511F	04-20-81	VPO	EX 536	05-15-81	05-01-81	N/R	N/R
M-95	Tk Mn Eng Jkt Wtr Exp	N/R	N/R	N/R	N/R	N/R	N/R	06-01-81	*	09-01-81	
M-96	Tk Mn Eng JW Clg Sys	N/R	N/R	N/R	N/R	N/R	N/R	06-25-81	*	09-01-81	
M-97	Htr Mn Eng JW Sys	03-23-81	03-17-81	505F	05-04-81	06-11-81	EX 535	06-01-81	05-22-81	09-01-81	
M-98	Cooler Mn Eng Piston F	03-23-81	02-26-81	511F	05-04-81	VPO	EX 538	06-01-81	05-01-81	09-01-81	
M-99	Tk Piston Clean F Wtr	N/R	N/R	N/R	N/R	N/R	N/R	06-01-81	*	09-01-81	
M-100	Tk Piston Clean H Wtr	N/R	N/R	N/R	N/R	N/R	N/R	06-15-81	*	09-01-81	
M-101	Tk F.O. Purif FW Oper	04-06-81	04-27-81	539F	05-18-81	VPO	EX 538	06-15-81	*	09-01-81	
M-101-2	Tk L.O. Purif F.W.Oper	NYA			NYA			NYA		NYA	
M-102	Tk D-G Jkt Wtr Expan	06-01-81	*		07-13-81			08-15-81		N/R	N/R
M-104	Tk Fuel Valve FW Expan	N/R	N/R	N/R	N/R	N/R	N/R	08-15-81		01-01-82	
M-106	Tk ME Air Cooler Chem	N/R	N/R	N/R	N/R	N/R	N/R	06-15-81	*	01-01-82	
M-107	Ht Exch Mn SW/FW	03-09-81	02-26-81	511F	04-20-81	VPO	EX 536	01-15-81	05-01-81	06-15-81	*
M-108-1	Tk Mn FW Cool Sys Expn	N/R	N/R	N/R	N/R	N/R	N/R	08-15-81		01-01-82	
M-108-2	Tk FW Drain & Inspect	N/R	N/R	N/R	N/R	N/R	N/R	06-15-81	*	01-01-82	
M-109	Cooler Feedwtr Sample	03-23-81	03-09-81	517F	05-04-81	06-11-81	EX 535	06-01-81	05-22-81	N/R	
M-110	Tk Boiler Chem Feed	N/R	N/R	N/R	N/R	N/R	N/R	06-15-81	*	10-01-81	
M-111	Tank Vacuum Priming	04-06-81	05-07-81	555F	05-18-81	*		06-15-81		N/R	N/R
M-112	Valve Vacuum Priming	04-06-81	05-07-81	555F	05-18-81	*		06-15-81		N/R	N/R
M-117	Cooler Tk Cln Htr & Dn	03-23-81	03-17-81	505F	05-04-81	*		06-01-81	05-22-81	10-01-81	
M-118	Dehumidification Sys	05-18-81	05-06-81	535F	06-29-81			07-27-81		N/R	N/R
M-119	Level Ind Car & Slp Tk	NYA	05-28-81	569F	NYA			NYA		NYA	
M-120	Level Indicator Aft Pk	04-06-81	*		05-18-81	*		06-15-81	*	11-01-81	
M-121	Monitor & Cntr Sys	03-09-81	04-27-81	538F	04-20-81	*		05-18-81	*	11-01-81	
M-122	Level Ind ME LO	03-09-8	*		04-20-81	*		05-15-81	*	11-01-81	
M-123	Level Ind LO Tk	05-04-81	*		06-15-81	*		07-15-81		11-01-81	
M-124	Level Ind FO Tk	05-04-81	*		06-15-81	*		07-15-81		11-01-81	
M-125	Level Ind Blend FO/DO	05-04-81	*		06-15-81	*		07-15-81		11-01-81	
M-126	Level Ind Pot Wtr Tk	05-04-81	*		06-15-81	*		07-15-81		11-01-81	
M-127	Level Ind Sewage Hld	05-04-81	*		06-15-81	*		07-15-81		11-01-81	
M-128	Level Ind Reserve F.O.	05-04-81	*		06-15-81	*		07-15-81		11-01-81	

DESIGN ENGINEERING FOR ZONE OUTFITTING
AVONDALE SHIPYARDS, INC.

PRODUCTION PLANNING INTERFACE

Prepared by: C. J. STARKENBURG

DESIGN ENGINEERING FOR ZONE OUTFITTING
PRODUCTION PLANNING INTERFACE

1. INTRODUCTION

The process of improving productivity by influencing design can, in general, be clasified into the following categories:

Designing on purpose to eliminate physical labor out of the final product.

Improving the efficiency of the labor flow in all the manufacturing processes.

Reducing material procurement and delivery problems to bare minimum.

Shortening the production schedule cycle times to efficient time frames.

The integration of Production Planning efforts with the design effort at Avondale is primarily concerned with all four of these categories.

We must keep in mind, however, that the ship designer is constantly constrained by the service and specification requirements of the contract.

It would appear then that there are really two aspects of ship construction, that is:

- design for ship performance;

- productability of ship's design.

Any economic advantage in the ship's construction period is directly proportional to the degree and the amount that these two aspects are integrated, early on in the pre-contract and early contract stages.

The cost control potential is seen in this chart developed by A&P Appledore, Limited and shown here in Figure No. 1.

At Avondale, we have concluded that the best medium, for production planning and design integration, is the hull block construction method and the zone outfitting technology we are now currently using.

Production and design integration is virtually limitless, restricted only by imaginative conception and design performance constraints.

A short review of the previously mentioned four categories will illustrate some of the highlights in the production/design integration.

A) DESIGNING ON PURFOSE TO ELIMINATE PHYSICAL LABOR OUT OF THE FINAL OR FINISHED PRODUCT.

Physical labor is energy expended that must be paid for in some fashion. Even slave labor must be cared for, fed, housed, and clothed. Therefore, designing on purpose to eliminate physical labor is designing on purpose to save cost. In this instance, the problem experiences of production become the physical labor costs. that are targeted for elimination by design.

An example of a problem is Shown in Figure No. 2A. In Figure No. 2A, the shell plate seams are laid in such a manner that they create fitting and welding problems wherever they cross the decks and flats. This creates unnecessary difficulty.

The integrated design and production solution is as follows and illustrated in Figure No. 2B. Design shell plate so that plate seams run parallel to and just above deck flats. This eliminates the necessity of weld seams crossing and intersecting deck flats. A brief example is shown in this illustration. Much time is saved by fitters and welders in completing these seams. Also, considerable scaffolding is eliminated.

Another problem area in outfitting is shown in Figure No. 2C, Example "A." The problem here arises when module hull units, which have been pre-outfitted on unit, become an interference to machinery packages which have been pre-outfitting on unit or on board.

The hull unit that is erected over the top of the pre-outfitted unit, when designed as shown in Example "A" with a hanging shell plate, creates a physical interference problem with the pre-outfitting machinery and walkways. This greatly inhibits the amount of pre-outfitting that can be done on the lower or tank top unit.

The solution here is to change the design somewhat, so that the shell section can be built into the lower unit as shown in Example "B" allowing the pre-outfitted items to be installed complete. This changes the shell plate from an item which was previously an interference to an item which is actually essential for successful zone outfitting.

B) IMPROVING THE EFFICIENCY OF THE LABOR FLOW IN ALL THE MANUFACTURING PROCESSES.

The design of the ship's structure and fittings has a tremendous effect on the routing and manufacturing of the component pieces and parts that make up the final vessel. An efficient order of labor flow is first created by the use of product work breakdown structure logic. The design then uses all the parameters created by this logic to develop the drawings necessary that will most suitably fit in with the methods chosen. An example of this is shown in Figure No.. 3.

In our adoption of the process lane method of hull construction, we have created, with the use of product work breakdown, a flow line of manufacturing hull assemblies. This flow line is a regimentation of work processes and schedules.

This regimentation of processes has required Production and Engineering to work very closely in designing work packages that fit within the parameters of the operation. We have found, for example, that a re-design of the docking brackets as shown in Figure No. 3 permits the welding of three longitudinal - L-1ST, L-15B, and L-lPB - to be done on the panel in the panel line process, instead of having to be done-manually after the assembly of the sub-unit into the hull unit as shown in Figure No. 4. This is done by simply re-designing~the configuration and installation clip brackets in lieu of the original one-piece design.

C) REDUCING MATERIAL PROCUREMENT AND DELI-VERY PROBLEMS TO A BARE MINIMUM.

Most material delivery problems originate in specifications to the vendor that require items which are, by design, unique. Engineering and Production together can decide to use many items which are standard in nature as opposed to being unique in nature.

These decisions are made very early in the contract and often prior to contract signing. Package unit configurations for auxiliary machinery fall within this category as do pipe rack packages for tanker ships.

The establishment of outfitting zones by the Production Department assists in the procurement of equipment and material by establishing scheduled sequences for material delivery.

It is possible by this method to schedule individual motor operated valves down to the individual valve date. This is of great significance for the vendor who manufactures the valve, as he is then able to work with established priorities.

D SHORTENING THE PRODUCTION SCHEDULE CYCLE TIMES TO EFFICIENT TIME FRAMES.

A fundamental objective of production and design integration is to simplify the production manufacturing process.

This is done by simplifying assembly methods and transferring the understanding of manufacturing methods from production to designers. The simplification of assembly methods is forced by constantly seeking to shorten the time frame of the production process.

This need to shorten the time frame continually creates ideas that feed back through the system to the designer for approval and compliance with his responsibility for performance. This, in turn, gives him the need to understand the assembly techniques that are to be used to implement the idea. The designer now becomes more familiar with the aspects of production and their attending problems.

This does not make life easier for the designer but, in turn, places more burden on him. Now the designer must not only create the design, but, must produce a design that facilitates better production methods as well as functional performance.

As seen by the illustration in Figure No. 5 production and design efforts begin very times in opposite extremes. But, by the constant process of feedback, both design and production can arrive at the ultimate optimum design that not only incorporates efficient assembly and production techniques, but also satisfies the function and performance requirements.

These techniques gradually develop into standard methods. The benefits derived from integrating production processes and design are readily apparent by most logical analysis. The problem occurs, not in an agreement that this is so, but in the methods and by whom it is subsequently implemented.

Design engineers are creative and talented people. Being creative does not lend itself to the adoption and continued use of mundane standards. Therefore, the creative challenge for the engineer must come from an observation of what his efforts are accomplishing in the completion of the finished product and the attending cost savings in labor and material.

This communication occurs through the media of a constant feedback process, wherein the engineer has become an integrated and vital part of the entire manufacturing procedure. This attitude must constantly be initiated and encouraged by the top management levels of the company.

Fortunately, we at Avondale have this commitment not only from our shipyard top management, but from the top management of our parent corporation as well.

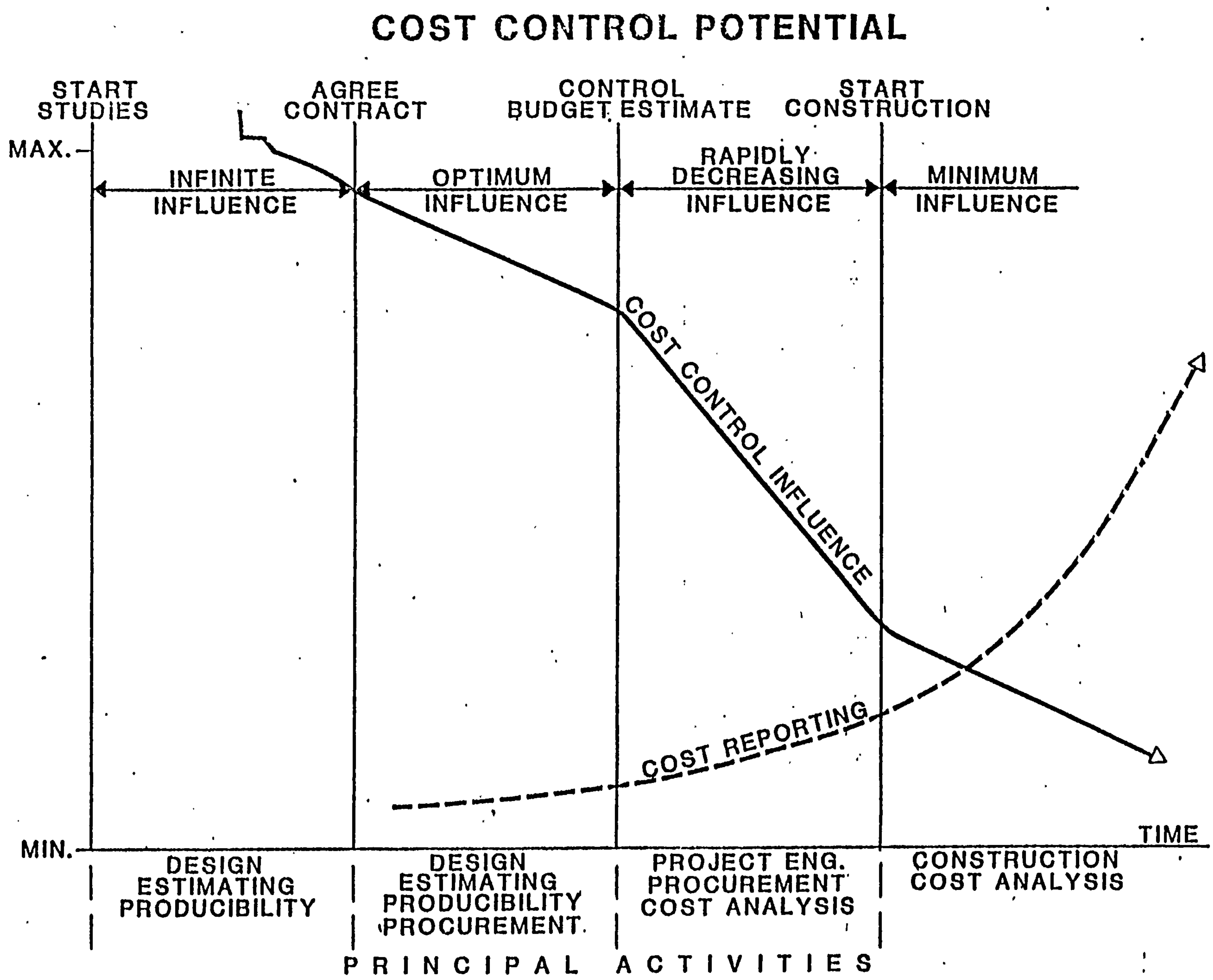
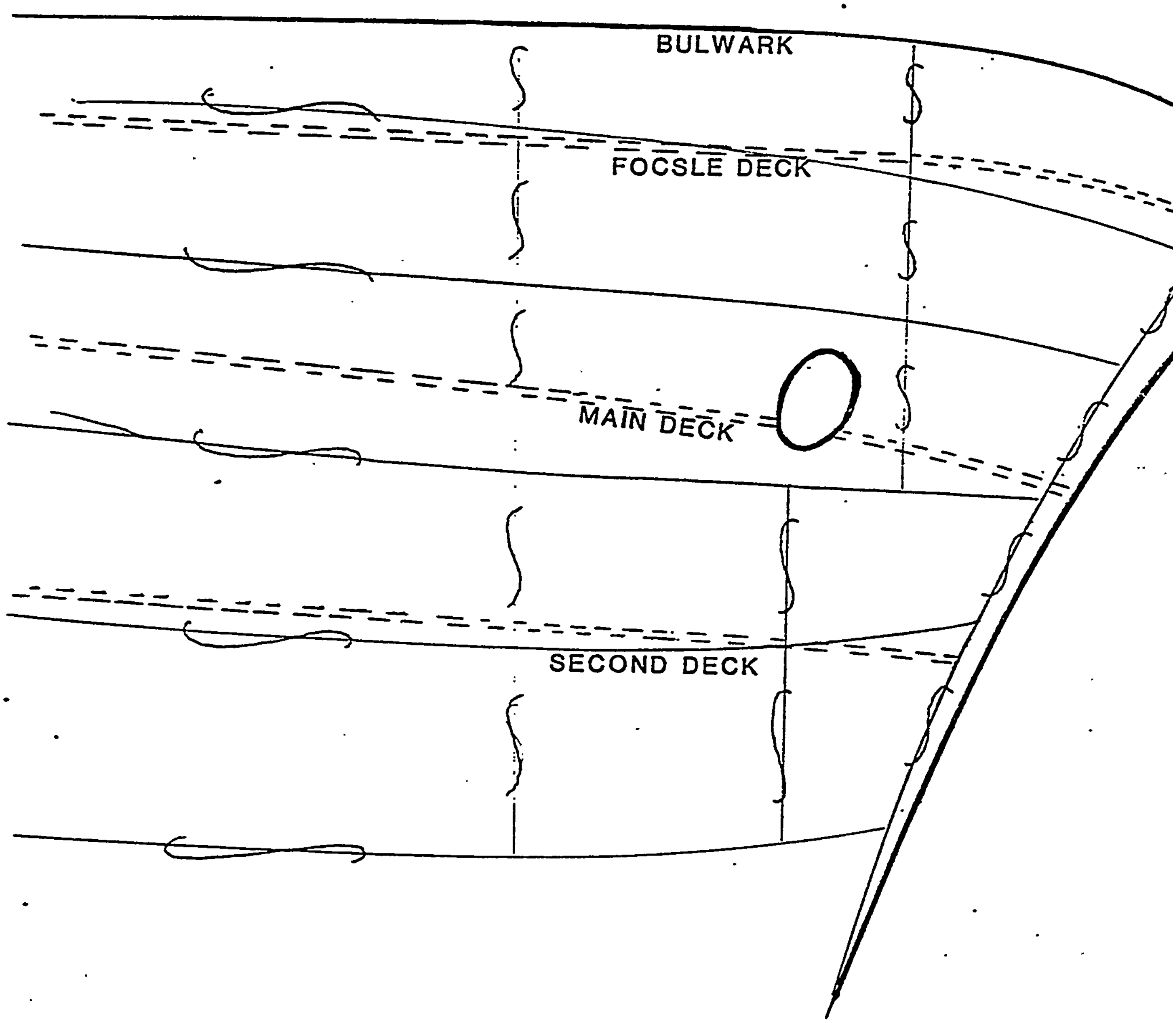
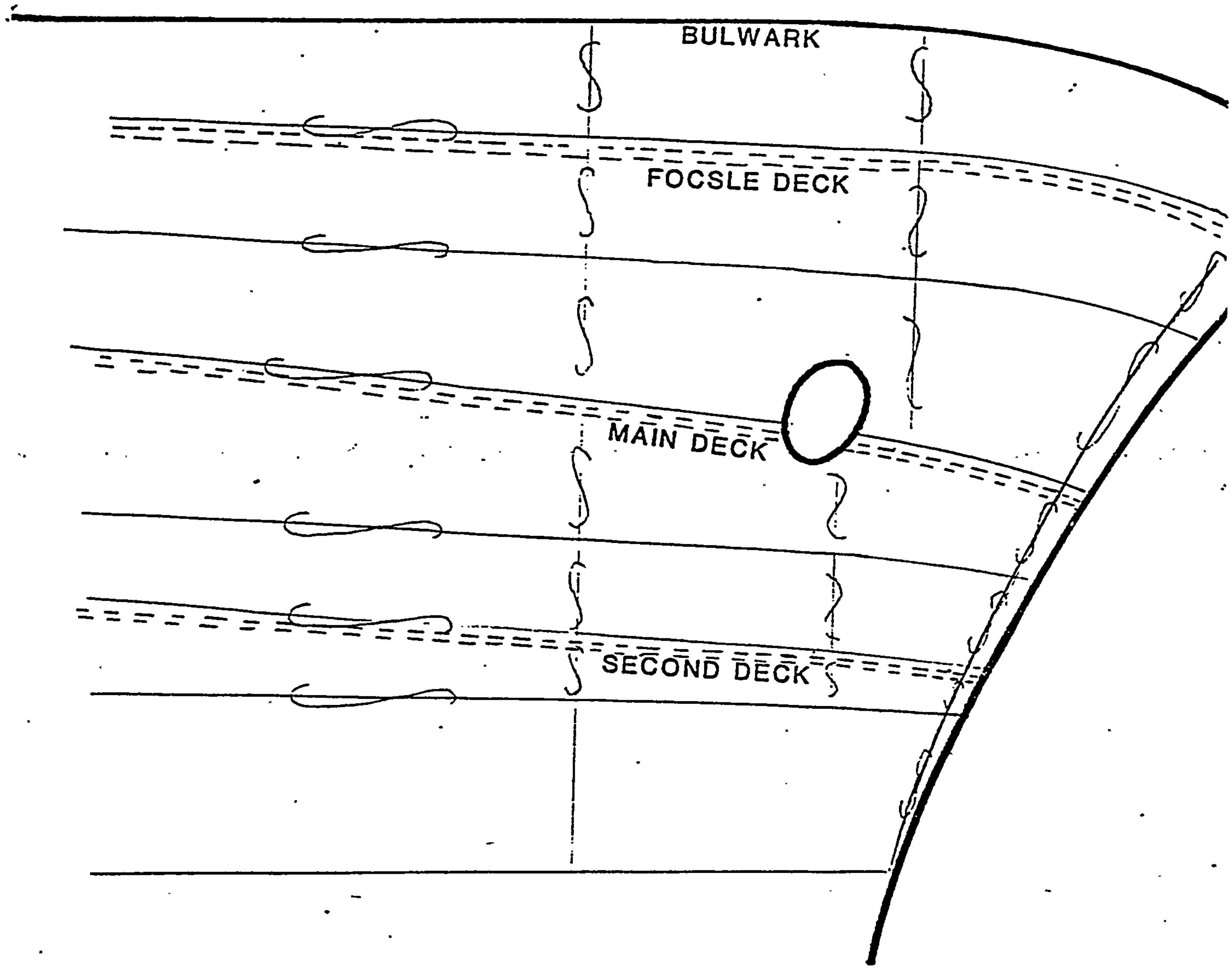

COST CONTROL POTENTIAL
START STUDIES
AGREE CONTRACT
CONTROL BUDGET ESTIMATE
START CONSTRUCTION
MAX.
INFINITE INFLUENCE
OPTIMUM INFLUENCE
RAPIDLY DECREASING INFLUENCE
MINIMUM INFLUENCE
COST CONTROL INFLUENCE
COST REPORTING
MIN.
TIME
DESIGN ESTIMATING PRODUCIBILITY
DESIGN ESTIMATING PRODUCIBILITY PROCUREMENT
PROJECT ENG. PROCUREMENT COST ANALYSIS
CONSTRUCTION COST ANALYSIS
PRINCIPAL ACTIVITIES

FIGURE NO. 1



BOW SECTION SHOWING HOW PLATE SEAMS RUN ACROSS DECKS AND FLATS, MAKING FITTING AND WELDING MORE DIFFICULT.

FIGURE NO. 2A



BOW SECTION SHOWING HOW PLATE SEAMS RUN PARALLEL TO AND ABOVE DECKS AND FLATS FOR EASIER FITTING AND WELDING.

FIGURE NO. 2B

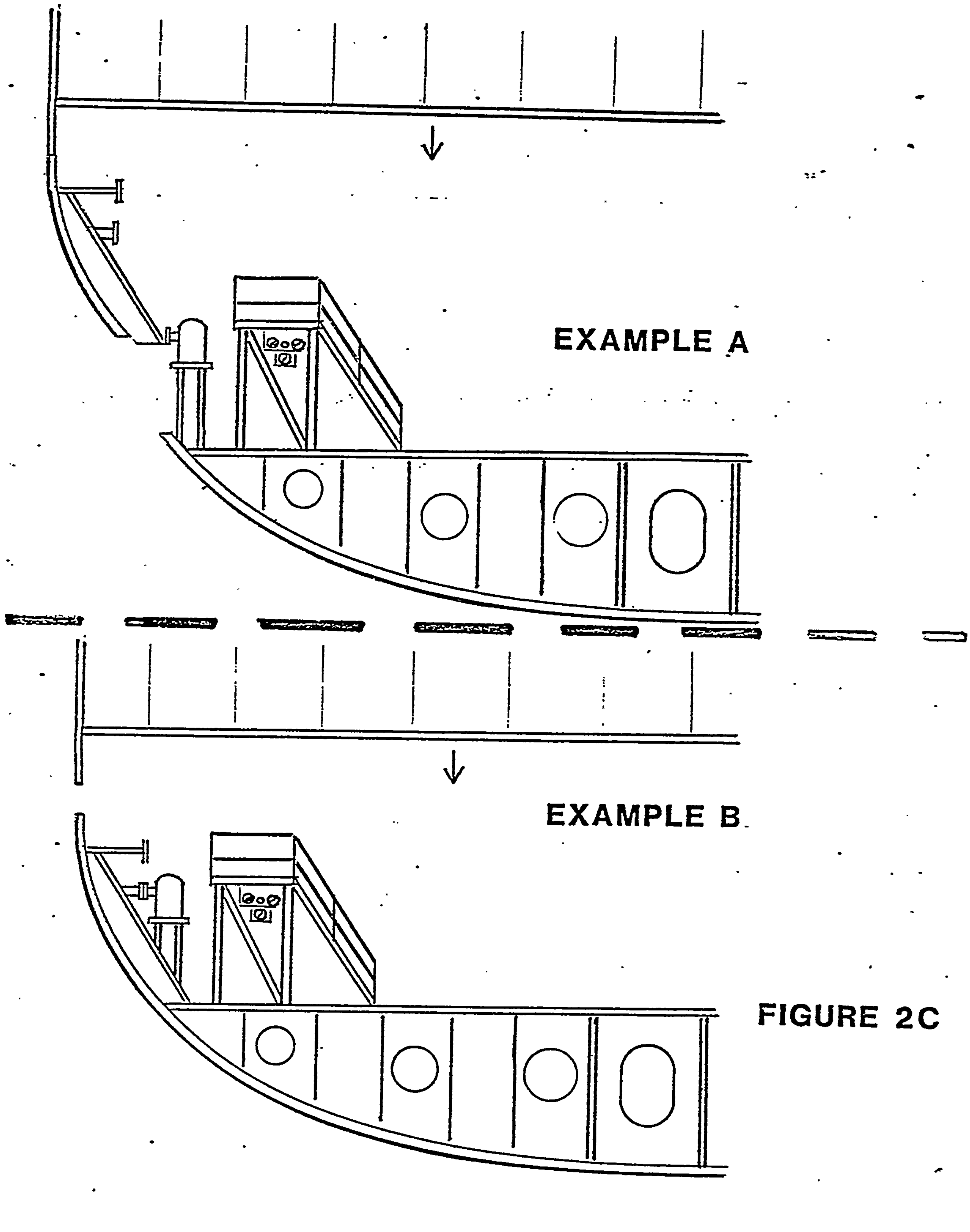
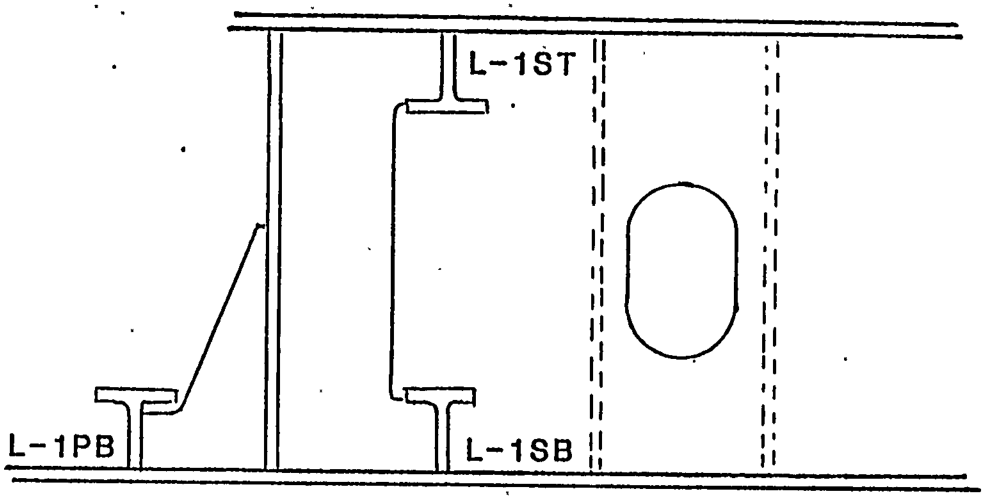
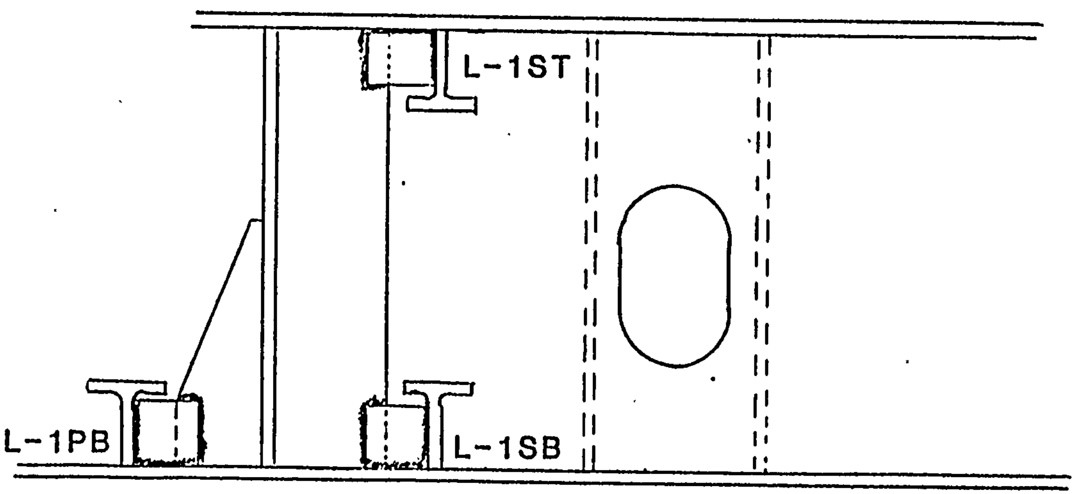


FIGURE 2C



EXAMPLE A

PRECLUDES PANEL LINE PROCESS WELDING OF LONGITUDINAL L# 1P BOTTOM AND L# 1S TOP AND BOTTOM



EXAMPLE B

ALLOWS ADVANTAGE OF PANEL LINE WELDING OF ALL LONGITUDINALS

FIGURE NO. 3

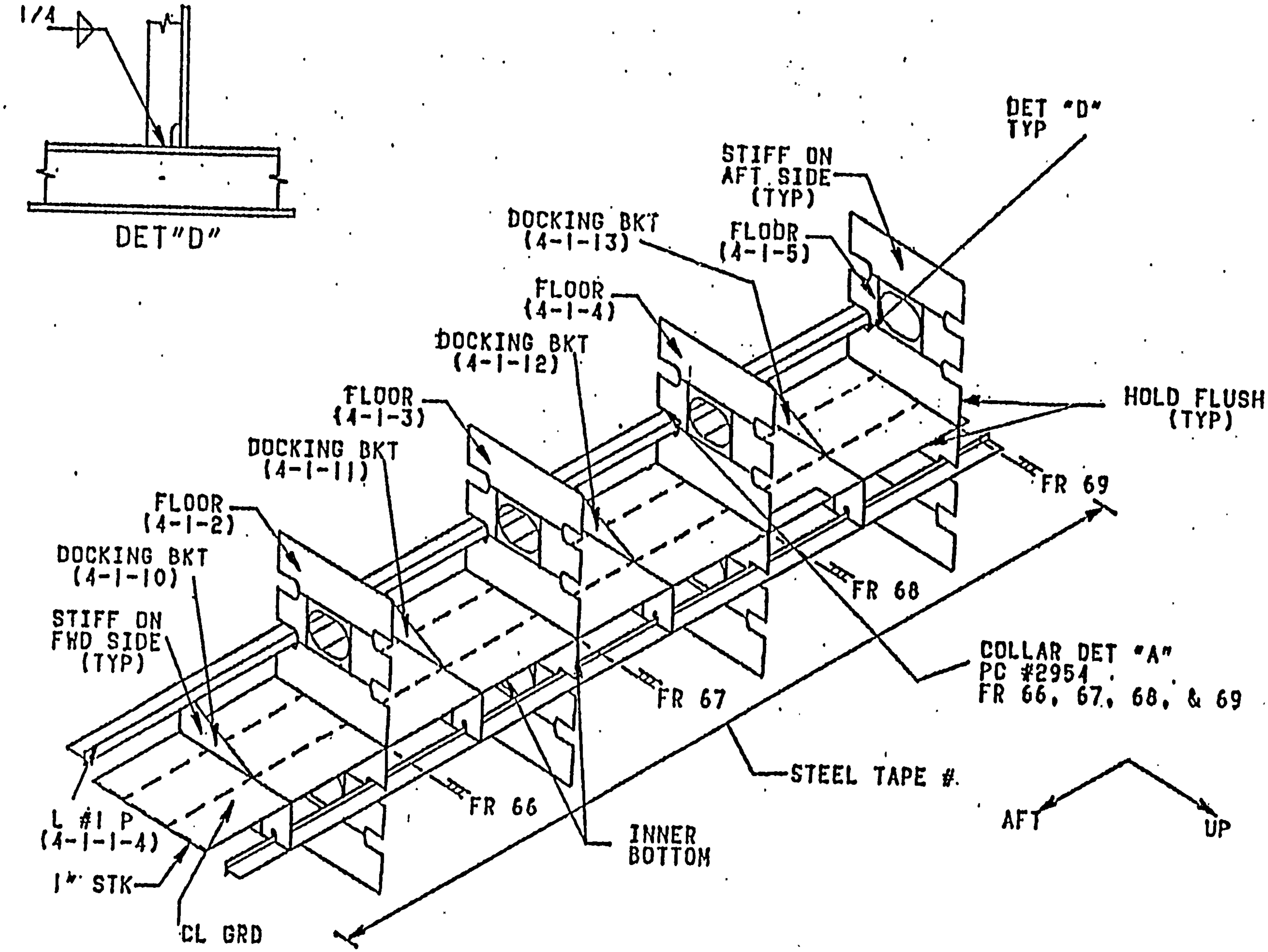
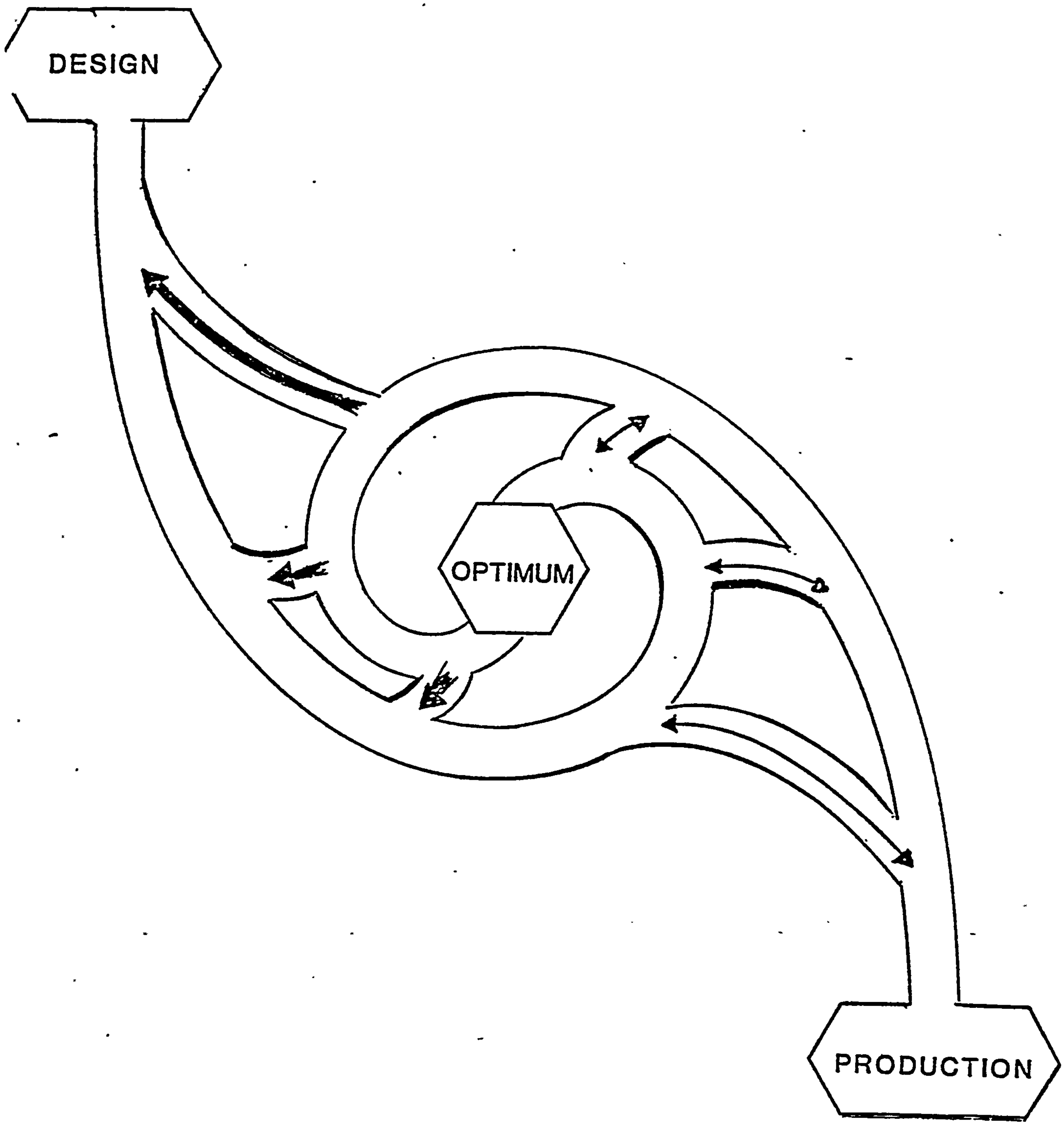

1/4
DET"D"
DET "D"
TYP
STIFF ON
AFT SIDE
(TYP)
DOCKING BKT
(4-1-13)
FLOOR
(4-1-5)
FLOOR
(4-1-4)
DOCKING BKT
(4-1-12)
HOLD FLUSH
(TYP)
FLOOR
(4-1-3)
DOCKING BKT
(4-1-11)
FR 69
FLOOR
(4-1-2)
DOCKING BKT
(4-1-10)
FR 68
STIFF ON
FWD SIDE
(TYP)
COLLAR DET "A"
PC #2954
FR 66, 67, 68, & 69
FR 67
STEEL TAPE #.
AFT
UP
L #1 P
(4-1-1-4)
FR 66
INNER
BOTTOM
1" STK
CL GRD

FIGURE NO. 4



SPIRAL FEEDBACK FOR OPTIMUM DESIGN

FIGURE NO. 5

DESIGN ENGINEERING FOR ZONE OUTFITTING
AVONDALE SHIPYARDS, INC.

MOLD LOFT INTERFACE

Prepared by: R. A. POURCIAU

DESIGN ENGINEERING FOR ZONE OUTFITTING
MOLD LOFT INTERFACE

1. INTRODUCTION

Avondale's Mold Loft is in the realm of Production and reports directly to the Vice-President in Charge of Production Engineering. The operation consists of four separate departments each having its own area of responsibility.

The Part Generation Section has the role of providing numerical control parts which are programmed and extracted from the "SPADES" data base. This group also provides the sketches for cutting structural. Each structural is placed on its parent part and validated for accuracy by utilizing CADAM CRT units. The nesting group uses these N/C parts in preparing computerized burning data for the N/C cutting machines. The Unit Control Manual (UCM) Department provides the pre-fabrication and fabrication drawings for hull work within the shipyard. This task is automated and computerized to a great extent by the merger of the CADAM and SPADES programs. These UCM work packages are distributed and maintained by the Loft. The conventional Loft provides the wooden templates such as roll sets, line heating templates, etc.

Much computerization is evident in the Mold Loft. The extensive use of CRT units with SPADES and CADAM programs provides the Loft with the flexibility to accommodate any job.

Hull Engineering and the Mold Loft communicate daily during the course of a contract. I will explain this interaction and the results achieved.

II. ANCHOR MODELS

Traditionally, the Mold Loft and Hull Engineering work in unison during contrcact development and actual construction of a vessel. These activities commence with the constructing of an anchor handling model which is utilized in determining the anchor handling arrangement of the ship. As the Engineering Design Section fairs the ship utilizing the SPADES fairing module, the Loft is provided with computer generated drawings from the data base. (See Graph No. 1 ML.) These drawings consist of waterline and buttock sections, deck contours, and vital control lines such as hull knuckles, stem profile, and stem tangents within the hull envelope. These drawings are used by the model maker to construct a replica of the ship's bow. This anchor handling model is usually at a scale of 1-1/2" = 1'-0" and is accurate in configuration to the full size vessel.

When the hull model is completed, items such as anchor bolsters and scale rigging are installed as per engineering design. At this time, Hull Engineering carefully scrutinizes the working model and recommends changes until a smoothly working prototype is assured. Dimensions crucial to design and fabrication are then lifted from the model. This pertinent data is entered unto the hull drawings for approvals and issuance.

III. SPECIAL DEVELOPMENTS UTILIZING CRT'S

Bulbous bows or bows of unusual shape always require that an intricate development be created when a bow thruster is required. If such a design is necessary, the engineers will give the N/C Mold Loft conceptual data defining the configuration. (See Graph No. 3 ML.) This data is then used with either N/C programs and/or CADAM CRT units to provide a medium for the loftsman to develop the structure. (See Graph No. 4 ML.)

As this work evolves, the moldloftsman will work closely with the Engineering draftsman in determining additional information for the engineering drawings. This information is in the form of developed offsets, angles of structure, work lines, auxiliary views and other pertinent data required for steel fabrication. CRT moldlofting also applies to rudders, stern tunnels, anchor pockets, skegs, stacks, and masts. (See Graphs No. 5 ML through 8 ML.)

Avondale feels that the application of CRT lofting provides an extremely accurate vehicle for producing complicated lofting layouts. These drawings are easily stored in the computer's data base and become readily available in the event of repair work or duplicate contracts of the vessel. By utilizing computer lofting techniques, the N/C loftsman maintains more visibility throughout the project and has the capability to quickly and accurately modify his layout to suit engineering design criteria. Accuracy is also held to a high degree with the use of computerized ship's data.

IV. SIGHT EDGE REFINEMENT

As work on the vessel progresses, the shell sight edges are defined. During this period, the Mold Loft and Hull Engineering work in close proximity to assure that the shell plating adheres to the IHI criteria for forming plates by the line heating method. (See Graph No. 9 ML.) Line heating is the process used to introduce compound shape into a plate without furnacing or cold forming. Each area of the ship is carefully studied to determine the most suitable condition for line heating. As the sight edges are changed, the engineering drawing and body plans are modified. This data is then entered and stored in the computer data base by the design section. This information is then available for recall by the Mold Loft’s N/C programming group.

The Mold Loft provides special "line heat" templates made on frame lines to the Blacksmith Shop. These templates contain a sight line and proper declevity for the frame. As the plate is line heated, the frames provide the proper transverse shape; as the sight line becomes straight, the correct amount of twist and longitudinal shape is introduced into the shell plate.

Due to the introduction of line heating technology, the Mold Loft has experienced a substantial reduction in the number of costly steel jigs required for forming shell plates. We have also monitored those units requiring line heated shell plates on the present Exxon contract and find that the shell plating fits significantly more accurately than on previous contracts. Naturally, we will realize a considerable savings in manhours at the assembly stage of construction.

V. SHELL PLATE - RAW MATERIAL SIZES

As an aid in efficiently purchasing the steel required for shell plating, the Loft utilizes the SPADES plate development program to obtain sizes of shaped parts. These sizes are given to the "Hull Steel Take-Off Section" for ordering raw plates. As each plate is defined to the computer, such pertinent items as the expansion factor for welding shrinkage, roll lines, tangents and production stock requirements are considered. The results of this effort are accurate plate sizes without excessive overage and maximized plate utilization in multiple part nesting. Each programmed shell plate is drawn for validation purposes by the Gerber plotter. The input manuscript is stored and later utilized for a production version that will be cut by N/C burning machines.

VI. UNIT PARTS LIST (UPL)

Hull Engineering provides the Mold Loft with the medium to determine the exact stage of fabrication for every piece of steel- in the ship. This document is referred to as the "Unit Parts List" and is used extensively by the Mold Loft planners and the "Unit Control Manual" (UCM) group.

The Mold Loft planners were established out of necessity due to the huge quantities of information flowing into and from the Loft. The planning effort lends itself to producing more consistency within the system.

The Unit Control Manual is a series of drawings produced by the Mold Loft from Hull Engineering drawings. these. "stage plans" address the different functions of hull work from the prefabrication process (see Graphs No. 10 ML and 11 ML) through the erection of the unit.. The concept is to provide the worker with only that information concerning his task. This theory is in accordance with the Japanese "Need to Know" philosophy. More detail concerning the UCM will be presented at a later seminar. The UPL evolves as piece numbers are assigned to the Hull Engineering drawings. The stage of fabrication is an integral part of the piece numbering system and is determined from the document produced by Production Planning called a "Unit Summary Sheet." The Unit Summary Sheet is the actual breakdown, assembly by assembly, of how the unit will be built, the identity of each fabricated part, and the location of that fabrication. Stock locations and amount are also indicated. Jig requirements are also specified, along with total weight and category of the unit. As the UCM stage plans are developed in detail by the Mold Loft utilizing CADAM and SPADES, refinements are given to Hull Engineering and Production Planning.

VII. PENETRATION CONIROL

Another aspect of the Mold Loft and Engineering’s close unis is in the area of structural penetration control. As piping systems are developed, interferences and continuity of holes in structure are checked by a special Engineering group. The Loft provides this group with N/C programmed parts of the area being validated. (See Graph No. 12 ML.) The engineers, via CADAM, display the part on the CRT, add the penetration in the proper location, and return to the Loft a drawing with the hole identification number, location, and size. The loftsman then utilizes this data to program the hole into the piece of steel being cut. Any discrepancies found with penetration location or size during the development process is fed back to the Hull Section.

VIII. STANDARDS

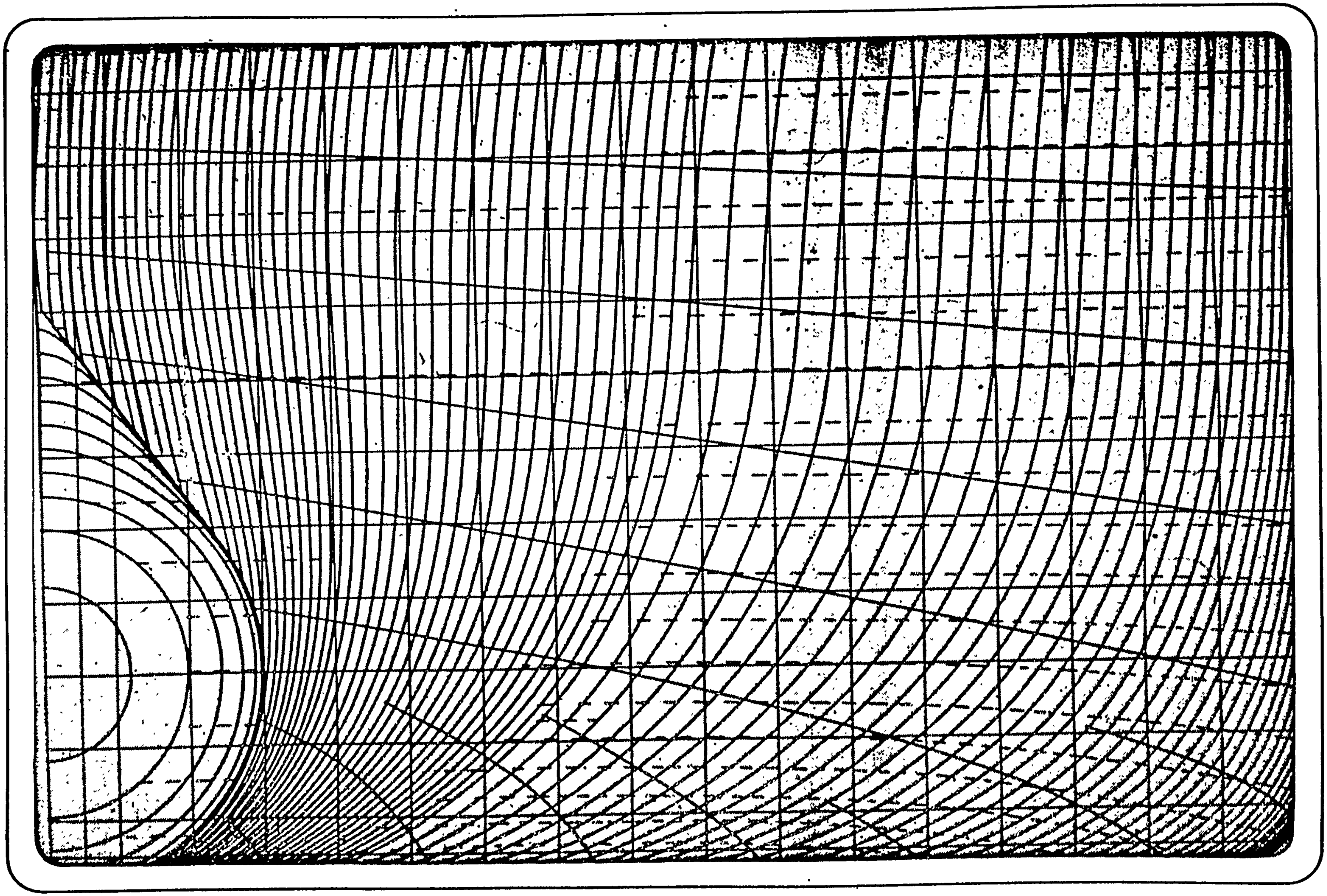
In an effort to reduce the quantity of different configurations, Hull Engineering and the Mold Loft join in the control and implementation of standards that affect:

- end-cuts for flatbars, angles, and tees;
- bracket configurations;
- clips and collars;
- structural cutouts (See Graph No. 13 ML) ;
- ratholes and waterstops;
- chocks ;
- drain and air holes.

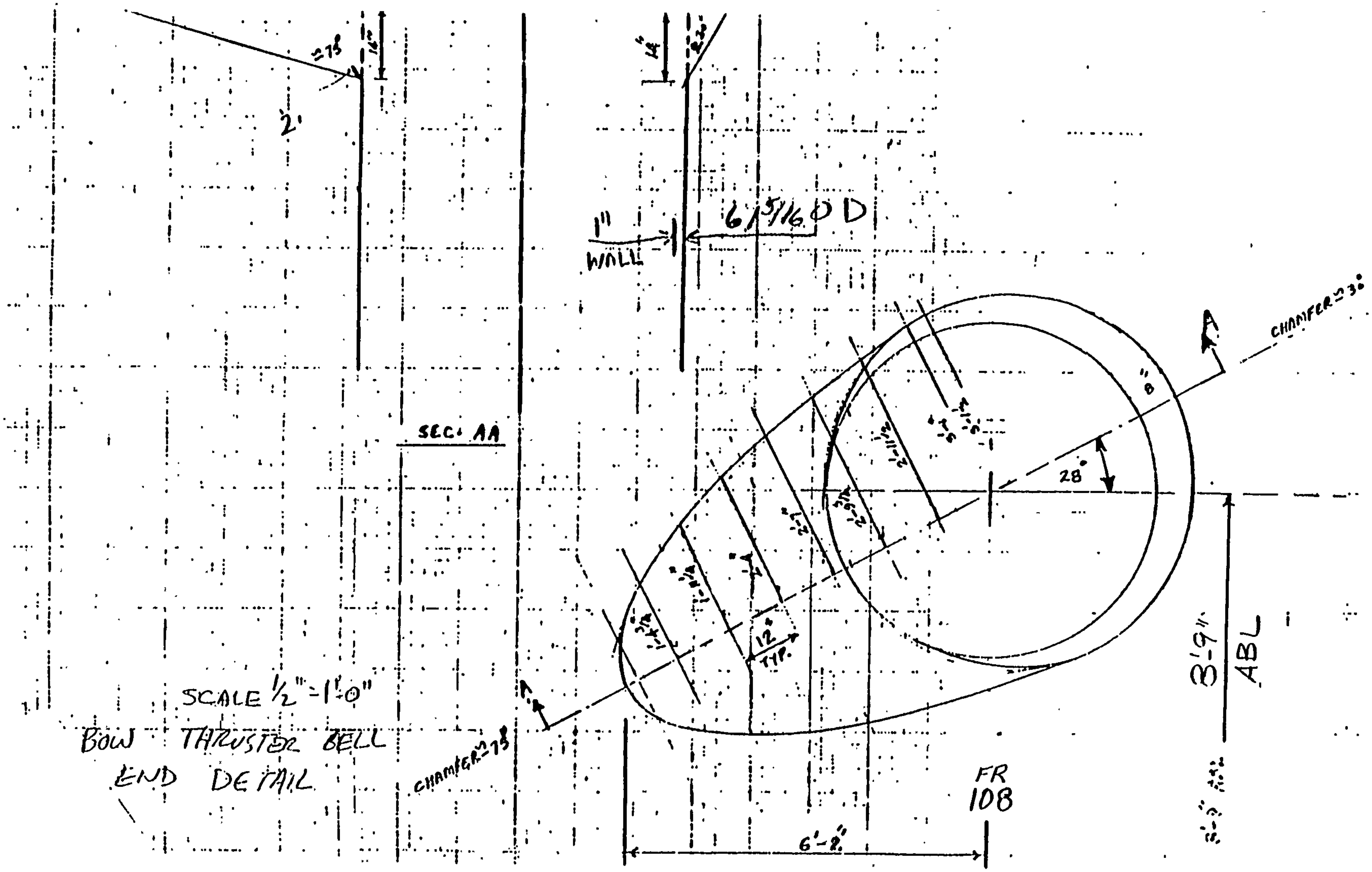
A comprehensive standard look has been assembled by Engineering and is extensively being utilized by the Mold Loft. These standards have reduced the matrix of items that the Loft and the yard must utilize on a daily basis. More consistency and less chance for error is also an advantage of this system.

IX. CONCLUSION

Thus, through close cooperation and the use of computer graphics and N/C programs, Hull Engineering and the Mold Loft complement each other in the complex task of ship construction.

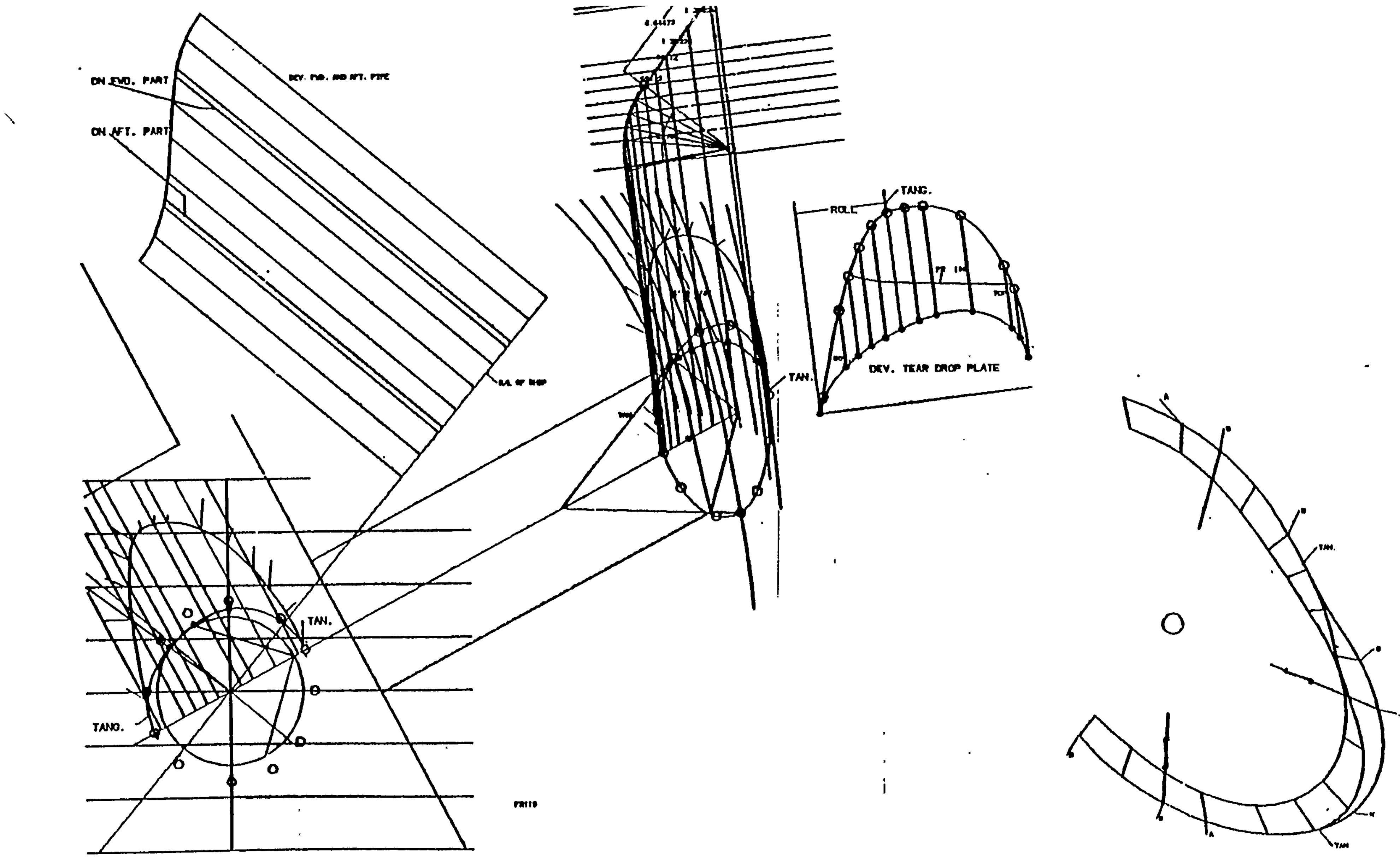


1 ML

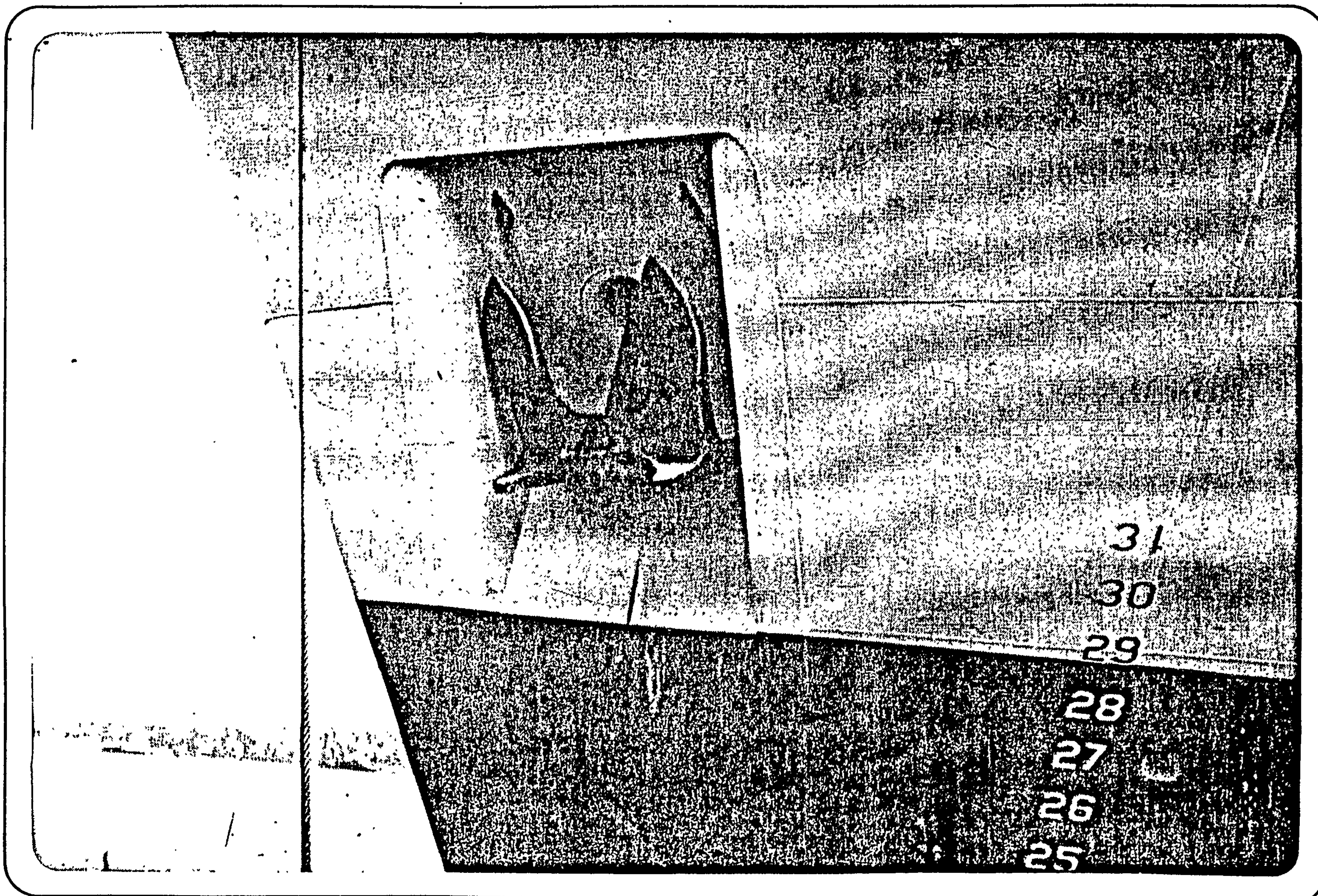


1" WALL
6 15/16 OD
SEC. AA
28°
CHAMFER ≈ 3/8
SCALE 1/2" = 1'-0"
BOW THRUSTER BELL
END DETAIL
12" TYP.
6'-8"
FR 108
3'-9" ABL

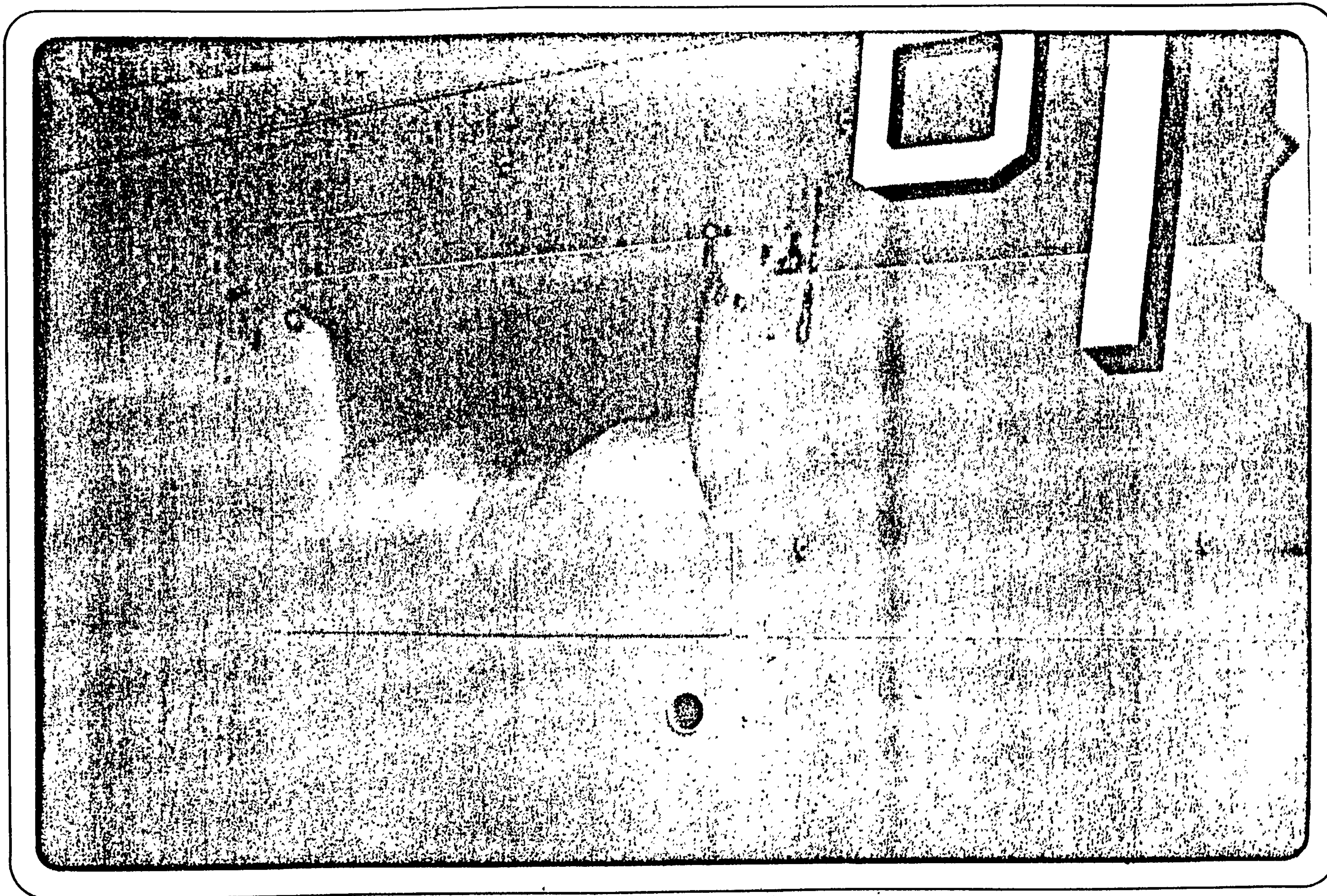
3ML


ON FWD. PART
ON AFT. PART
TAN.
TANG.
ROLL
TANG.
TAN.
DEV. TEAR DROP PLATE

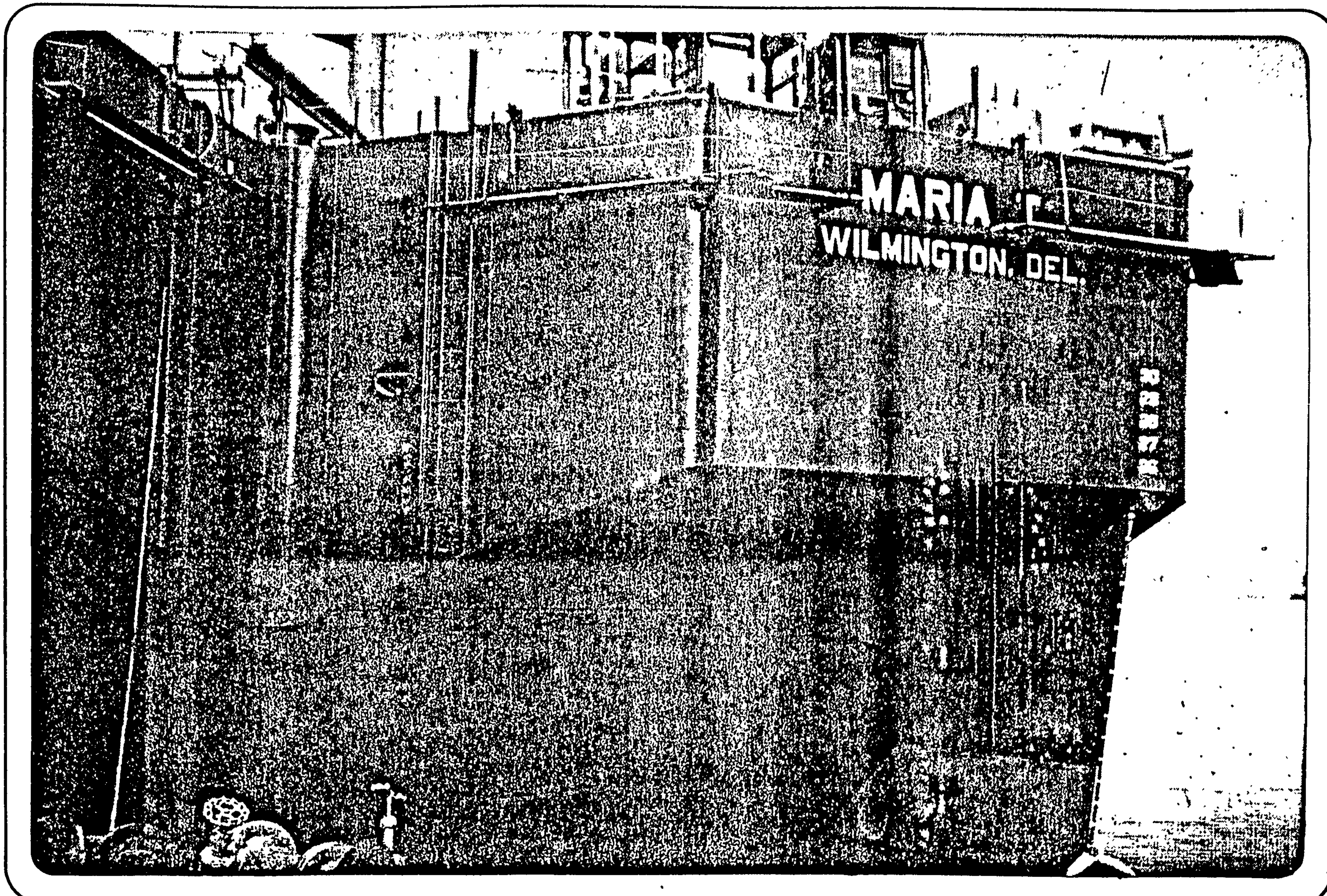
4ML



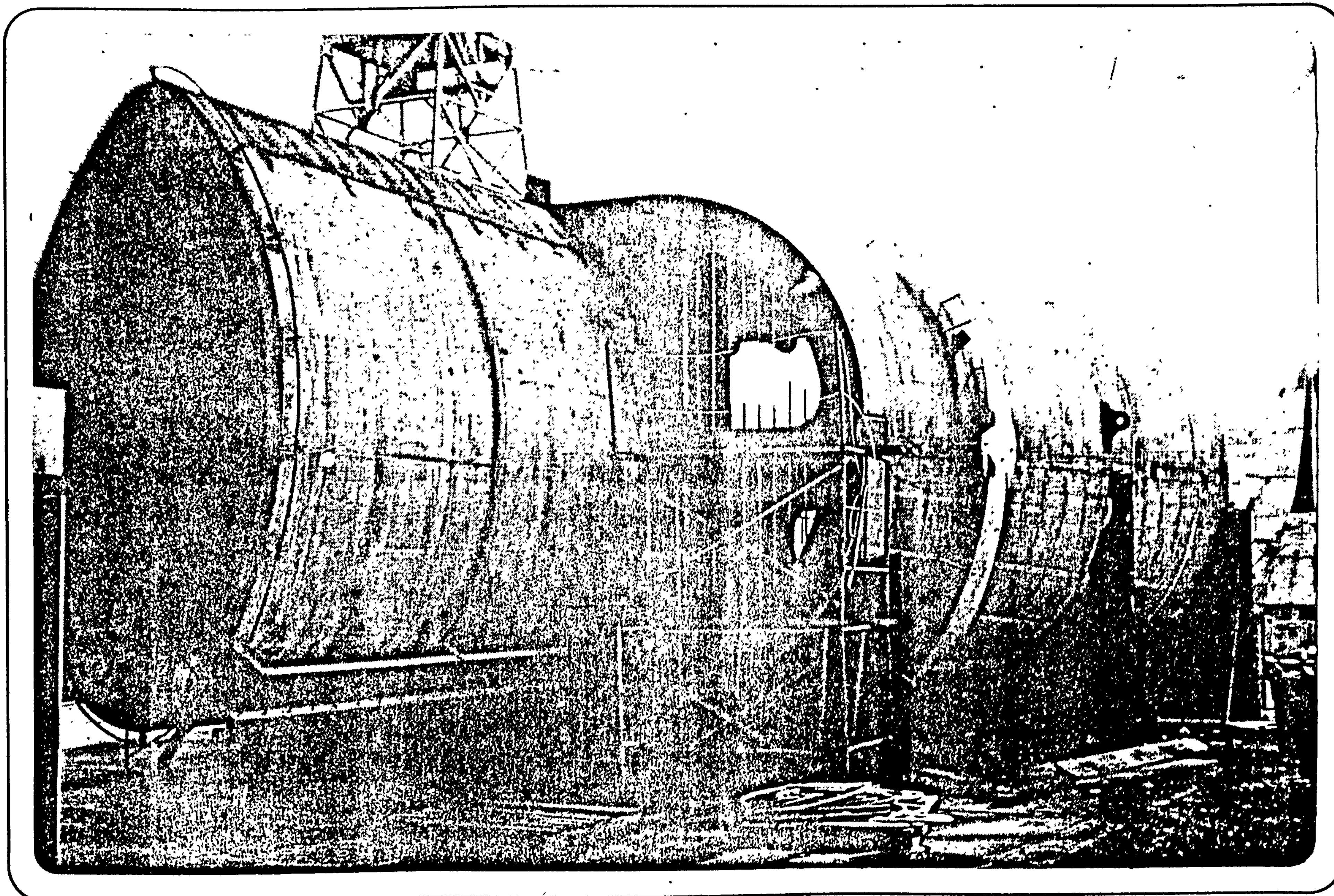
5 ML



6 ML

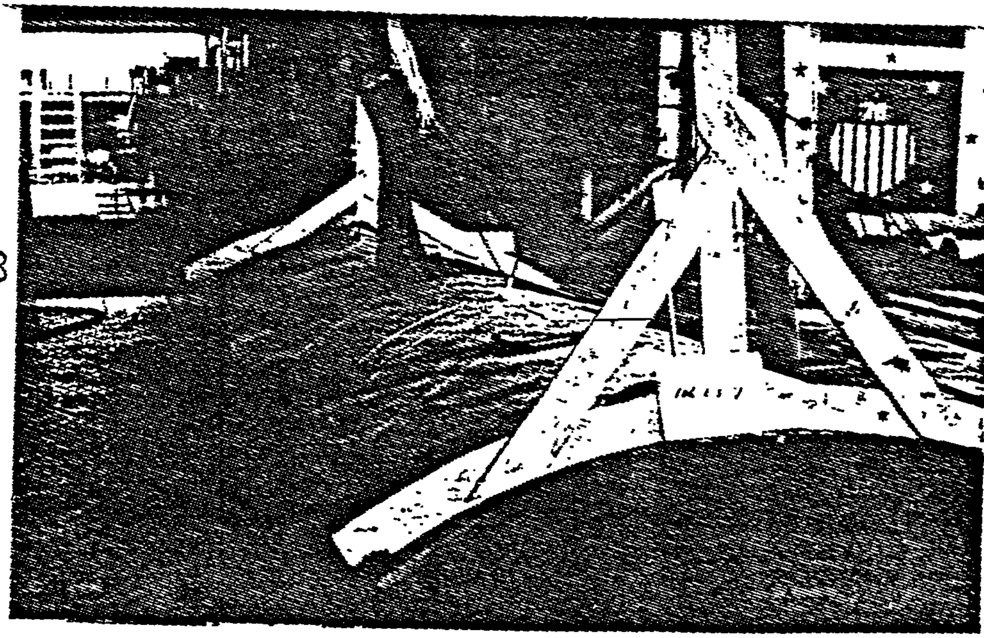


7 ML



8 ML

PHOTO 18



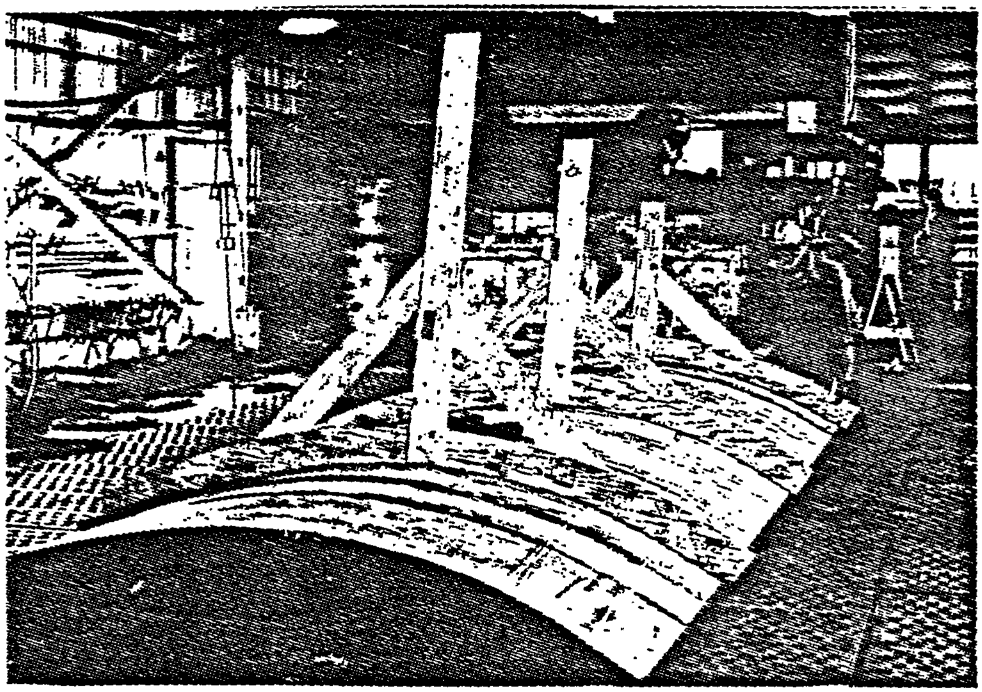
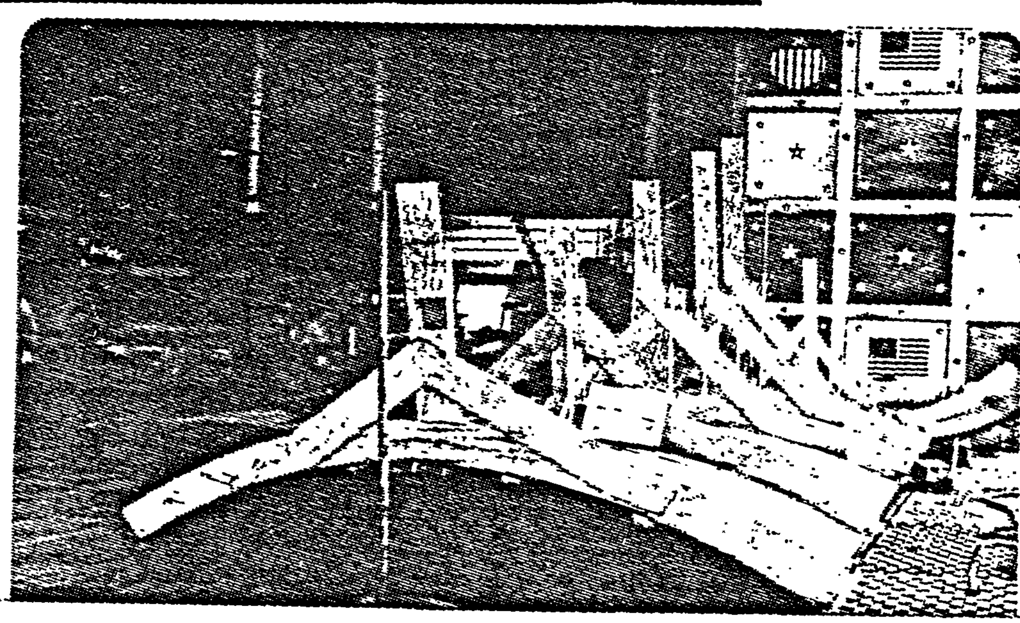
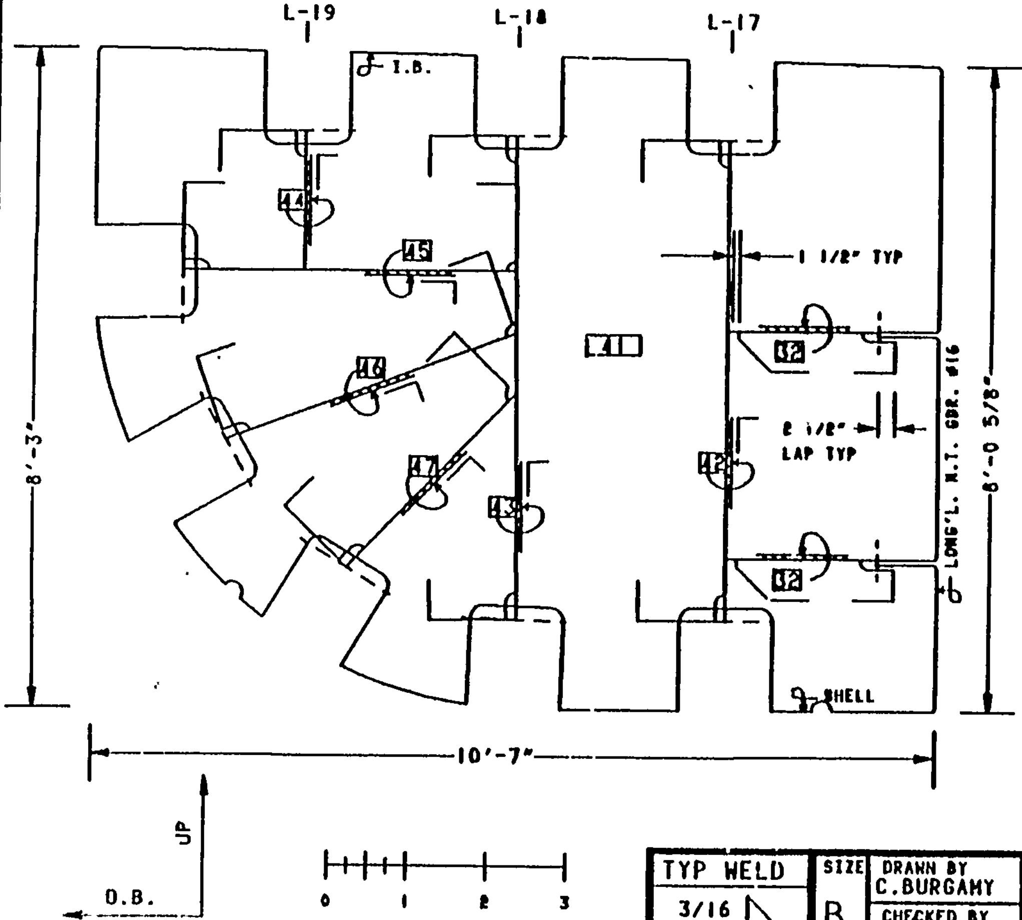


PHOTO 19

PHOTO 20

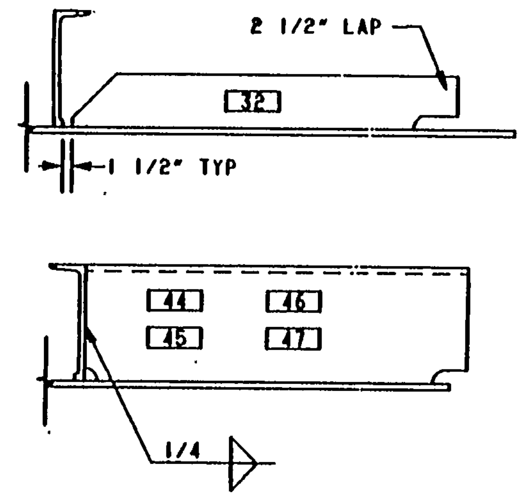


9 ML



PARTS LIST

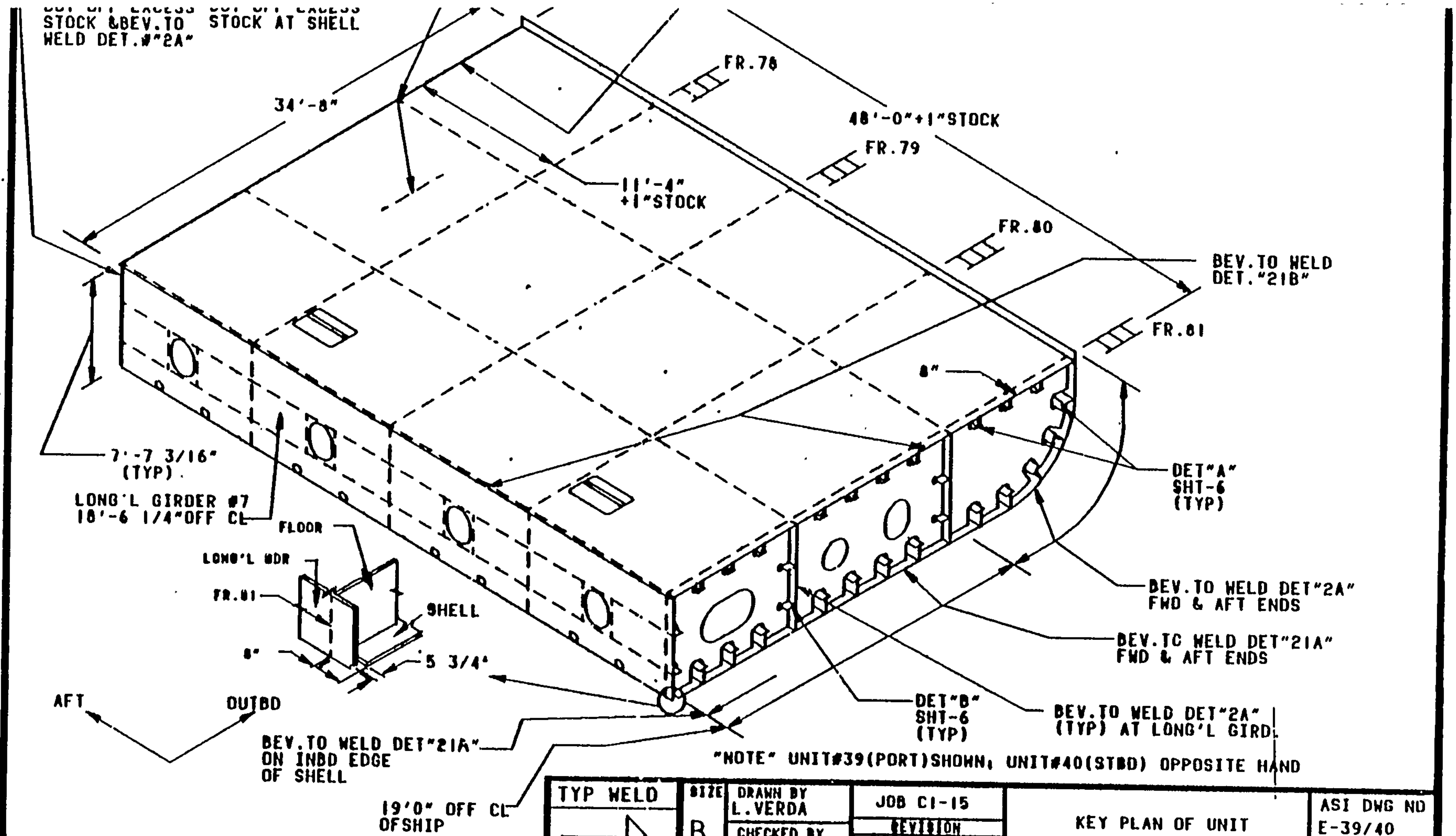
R	LN	PIECE NO.	QTY P	QTY ℄	QTY S	MATERIAL	GRADE
	1	39-1-20-41	1			19/32" PLATE	AH-32
	2	39-1-20-42	1			HC 13 X 31.8# C/L	AH-32
	3	39-1-20-43	1			HC 13 X 31.8# C/L	AH-32
	4	39-1-20-44	1			HC 13 X 31.8# C/L	AH-32
	5	39-1-20-45	1			HC 13 X 31.8# C/L	AH-32
	6	39-1-20-46	1			HC 13 X 31.8# C/L	AH-32
	7	39-1-20-47	1			HC 13 X 31.8# C/L	AH-32
	7	39-1-20-32	2			5/8 X 6 F.B.	ABS/A



WORK SHEET 9/81

TYP WELD	SIZE	DRAWN BY	JOB C1-15	PLATING & STIFFENER ARRGT. W.T. FLOOR FR.80	ASI DWG NO
3/16	B	C.BURGAMY	REVISION		PSU 39-1-20
		CHECKED BY M. Gillian	0		SH NO 18

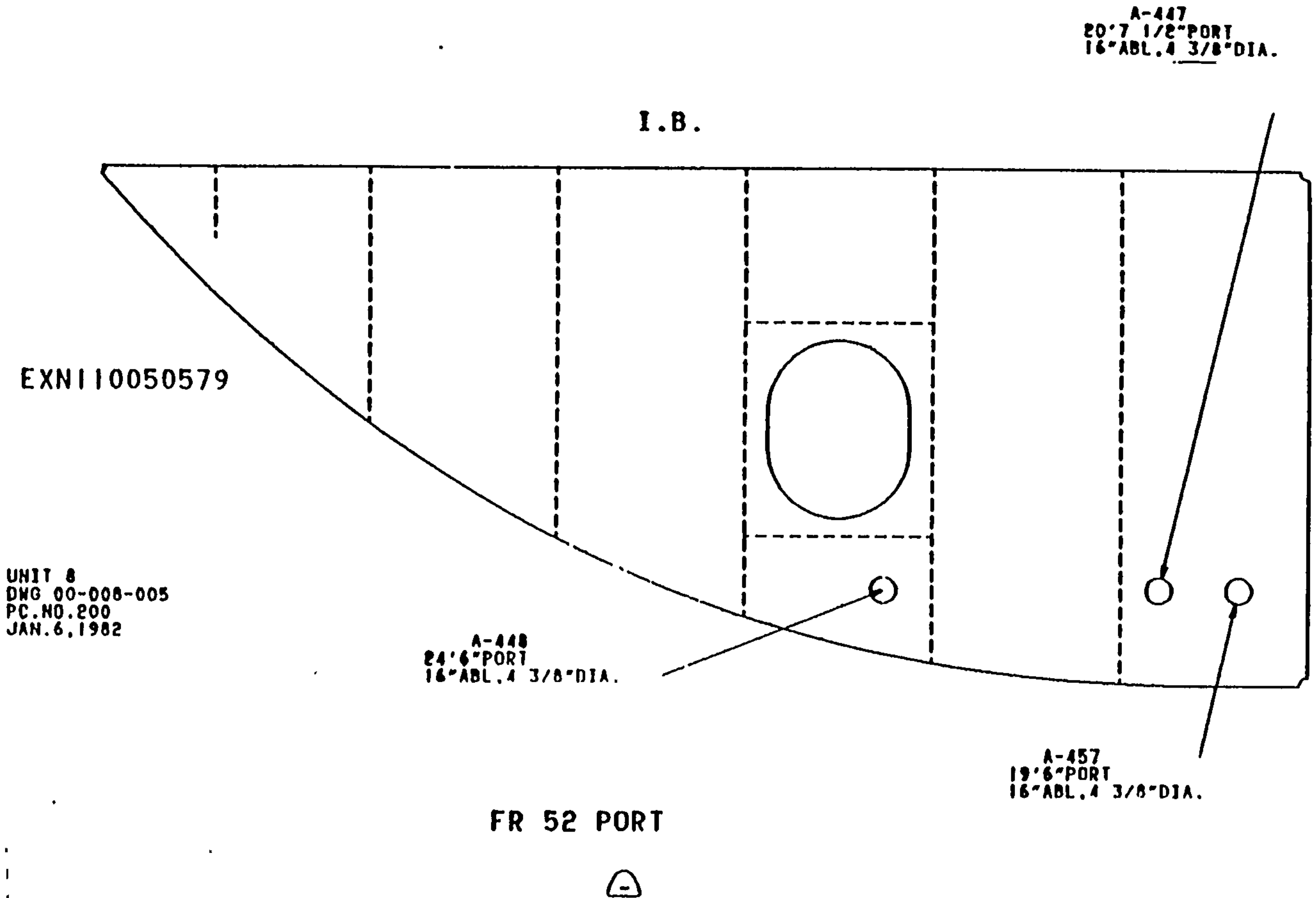
10ML



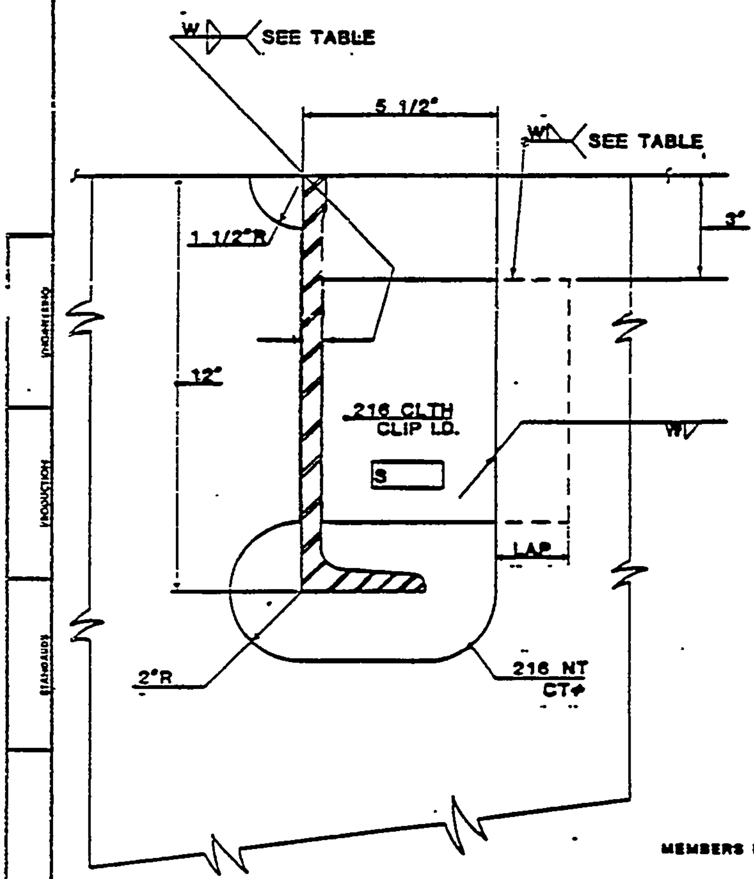
TYP WELD	SIZE B	DRAWN BY L.VERDA	JOB C1-15	KEY PLAN OF UNIT	ASI DWG NO E-39/40
		CHECKED BY M. Gallicano	REVISION		SH NO 5

ISO. WORK SHEET 9/81

11ML


A-447
20'7 1/2"PORT
16"ABL,4 3/8"DIA.
I.B.
EXN110050579
UNIT 8
DWG 00-008-005
PC.NO.200
JAN.6,1982
A-448
24'6"PORT
16"ABL,4 3/8"DIA.
A-457
19'6"PORT
16"ABL,4 3/8"DIA.
FR 52 PORT

CLIP TABLE					
TH		STD PC MK	W	SIZE	WGT LBS
16TH	INCH				
4	1/4	S 1157	3/16	7 X 7	4.
5	5/16	S 1158	7/32		5.
6	3/8	S 1159	1/4		6.
7	7/16	S 1160	9/32		7.
8	1/2	S 1161	5/16		7.
10	5/8	S 1162	3/8		9.
12	3/4	S 1163	7/16		11.



MEMBERS MC 12"x3 1/2"x30.9,32.9 OR 37.9#

SPADES.DBCT# 102NT

AVONDALE SHIPYARDS INC P O BOX 50280 NEW ORLEANS, LA 70150	STANDARD / AS SD	TITLE: CT & CL 12" X 3 1/2" DEFL. CHANNEL	DWG NO 216 NT	REV 1
			SCALE / DATE 12/15/~~80~~	SH NO __ OF 139

DESIGN ENGINEERING FOR ZONE OUTFITTING
AVONDALE SHIPYARDS, INC.

MATERIAL CONTROL SECTION INTERFACE

DESIGN ENGINEERING FOR ZONE OUTFITTING
MATERIAL CONTROL SECTION INTERFACE

I. INTRODUCTION

Until recently, all ships built at ASI were outfitted on a system basis that considered system functions throughout the ship. **Material** Control, as a result, looked at material in rather large and cumbersome lots. Our first attempts at on-unit outfitting were on conventionally engineered drawings which were broken down to suit on-unit construction, but not for the purchasing or controlling of material on a unit/zone basis. This resulted in a rather confused hybrid system which was system oriented but somewhat "on unit" outfitted. Since all L/M's were generated from system drawings, the attempt to extract parts of each system, such as PD's, valves, ladders, foundations, etc., and fit them into the unit to which they belonged, became an an arduous task, especially so since all record keeping and material take-offs were accomplished manually. However, as time went on, later contracts. were better defined and eventually engineered on a unit and zone basis which eliminated the consideration of systems and concentrated the L/M's into small packages for "on unit" or "on board" outfitting.

Some progress has been made already in the conversion of the Material Control record keeping function from a totally manual system to one that is partially computerized, and it is anticipated that these changes will continue. Eventually, in order to keep pace with the rapid flow of material and information, a fully computerized material control system will be developed.

The Material Department at ASI is mainly concerned with the receipt, storatge, recordation and delivery of outfitting materials to Production as required. This would include parts and pieces required to build assemblies, as well as finished sub-assemblies and purchased items.

II. THE PALLET CODE (MC-1)

The key to the proper scheduling and supplying of each unit, with the material required for outfitting at the time it is required, is the pallet code. Each item of material, whether a piece needed to produce a sub-assembly, an item purchased for installation, or a completed sub-assembly, must be pallet coded. This pallet code ties all the materials necessary to pre-outfit a unit together and identifies the stage or time frame at which the material is to be installed. The pallet referred to here is actually a grouping of material necessary to outfit a certain portion of a unit or zone within a specified time frame. It may be many containers and large loose pieces, or it may be that 4' x 4' wooden platform which we normally call a pallet.

III. COMPARISON BETWEEN SYSTEM OUTFITTING AND ZONE OUTFITTING METHODS

Comparisons of outfitting methods and their impact on material handling at ASI can be made in three major categories:

- pipe and pipe fittings delivered to the Pipe Shop for fabrication into sub-assemblies (PD's);

- fabricated pieces (PD's manholes, ladders, foundations, etc.) ;

- purchased material stored in warehouses.

These constitute the areas of zone outfitting furthest advanced at ASI and will be the models used for future development by the Material Department.

IV. PIPE AND FITTINGS FOR FABRICATION BY THE PIPE SHOP

Prior to the Exxon and APL contracts, all fabricated pipe pieces. were built on a system basis for each hull, except during the transition period when fabrication was done partly by system and partly by the zone concept. The transition period, although difficult and at times frustrating, proved to be a necessary learning experience which helped provide the understanding necessary to accomplish the task of pre-outfitting on Exxon and future contracts. Under the old system-by-system method of fabricating pipe details, the Mechanical Section of Engineering would produce L/M's taken from diagrammatic system drawings for advance ordering of materials. These L/M's were screened by Material Control against all available materials on hand such as stock, surplus, job overages, etc., with the remaining material requirements forwarded to the Purchasing Department for buying. This established the stock of the material generally required for each system which was recorded in ledgers according to diagrammatic drawing number. As each system became more clearly defined and pipe detail sketches were completed, a PD drawing booklet, along with a L/M for the entire system, was released (MC-2 & 3). This L/M, which included both materials required for fabrication and materials required for on-board installation, was then screened against its designated diagram- matic L/M and all other available sources with the remaining requirements sent to the Purchasing Department.

During the transition period, since a unit or zone would contain parts of each system routed through it, the screening against diagrammatic L/M's became time consuming and frustrating. For instance, where several systems could usually be screened from one diagrammatic L/M under the old system, we were now faced with the possibility of material for one unit being screened from 10 to 15 different diagrammatic L/M's.

In order to separate those items required for PD fabrication from those that would install on board, it was necessary to do a material take-off on each PD sketch and group them together in a piece mark sequence material summary **(MC-4). When a work** order was issued to begin fabrication, all the material on the PD material summaries were sent to the Pipe Shop. As systems were started and under way and other systems begun, a large quantity of material was usually on hand at the Pipe Shop at any given time, leading to shop overloading and replacement material problems.

Therefore, before releasing any materials to the Pipe Shop, the shop superintendent was contacted to determine if the shop load would permit delivery of the material at that time. If the shop was in a position to accept the material, the material engineer released the material requisitions to the warehouse for delivery, and at the same time issued a material deficiency report indicating shortages to the Pipe Shop for informational purposes and to the Expediting Department for action. All material not on hand at the time of delivery was designated "deliver on arrival" and sent to the Pipe Shop upon receipt. If, on the other hand, the shop superintendent decided not to fabricate. the system at that time, the material requisitions were held by the material engineer until called for.

However, a work order being issued to install "on board" system material did not trigger delivery of all remaining material to the ship. Rather it was left to the installing foreman to call for the system being assembled as needed.

Today, diagrammatic pipe drawings are still used to advance order materials much as under the old system concept and screened against all available material on hand before any materials are purchased. Also, all recording of L/M's, purchase orders, receipts, and issues are still handled manually in material ledgers.

In order to screen materials more effectively, the Material Control Department is provided a weekly computer generated listing by job in piece mark number sequence for materials advance ordered on diagrammatic L/M's (MC-5). This eliminates the time spent searching through material ledgers and allows the entire pool of diagrammatic L/M's to be screened from, thereby eliminating unnecessary material purchases. Also, recently made available to Material Control is computer capability to search all jobs for any given piece mark number. These two new capabilities have greatly reduced the time required for screening while improving efficiency.

The work-load on the Material Control Department has not decreased under the zone outfitting concept, but it is felt that the real cost savings will come from the crafts having just the material required for a small task arriving when needed.

Under the new zone outfitting concept, the Mechanical Section of the Engineering Department produces pipe detail drawings for each unit. These PD sketches contain all the pipe details to be fabricated for the particular unit, regardless of which System they belong to. Each PD is assigned a pallet code which is used to eventually marshall all PD's accordingly. All of this information is then input to "Copies" for purposes of scheduling and determining material requirements by pallet code. From this information, a weekly shop load list is produced containing all of the material for Pd fabrication for each pallet that is scheduled to start fabrication that week (MC-6).

In order to have time to review the list for any possible errors, omissions or material shortages, the list is printed three weeks in advance of the fabrication start date. After reviewing the material listing from Data Processing, the material engineer determines those PD's for which 100% of the required materials are available. These PD's, to which individual shop order numbers are computer assigned, are released for fabrication via a CRT terminal located in the Material Control office. This information is then available to the Pipe Shop superintendent and the Production engineer who may then release a work order to fabricate the released PD's. As with the old system, material requisitions are sent to the warehouse for delivery and material deficiencies are sent to the Pipe Shop for information purposes and to the Expediting Department for action. The materials delivered to the Pipe Shop are separated into categories such as flanges, elbows, tees, reducers, etc. to facilitate machine station loading. Any PD's not released will be listed by required date as past due on all future computer listings until the material shortage is filled and the PD is released by Material Control. Unlike the old system, the Pipe Shop superintendent is not conferred with prior to material deliveries, as the schedule plus the PD releasing activity permits him to level load somewhat in advance.

V. FABRICATED OUTFITTING MATERIAL

The handling, storage and delivery to Production of fabricated pipe pieces under the old system concept was originally controlled by the Pipe Shop, itself, in that once a system was fabricated, all the pipe pieces were palletized and stored in racks at the Pipe Shop. When the installing forman required the first PD's to begin assembly of a system, he requested the entire system of PD's from the Pipe Shop. This meant that a search through all PD's fabricated for that system was required to obtain the PD's needed for installation that time. The length of time required to fit an entire system usually resulted in many pipe pieces being lost, damaged or deteriorating due to long exposure to the weather.

About five years ago, it was decided, due to the ever increasing volume of fabricated pieces, that the Material Department would take over the storage, routing required through coatings, and ultimate delivery to the construction site, as required. This merely shifted the burden of finding the pieces needed from the installing foreman to the Material Department. The original idea for recording and storing the PD's was based on random access with a Kardex file used for recording the various storage locations within each system. As PD's were needed to fit the system on board, the installing foreman would request only those PD's needed at that time. These PD's were located on the Kardex file, each location noted and a picking list made. After gathering together the PD's requested, delivery was made to the job site. The same problem of possible damage, loss or deterioration still existed as before, but the pipe installers were now somewhat freed from material handling.

During the transition period from system orientation to zone outfitting, the record keeping and retrieval of PD's became infinitely more complex. The storage area soon had to be expanded to accommodate the ever growing number of PD's being held pending delivery. Also, more and more manhours were being spent gathering PD's from many different systems in various locations in an attempt to fill the unit outfitting requirements.

Today, especially on the third ship of the APL contract and beginning with the first ship of the Exxon contract, a smooth efficient system has replaced the chaos of the past. Since PD fabrication now is forced to follow the master unit schedule, far fewer PD's will be held in storage at any given time and they will remain in storage for a much shorter time.

As PD’s are fabricated, they are taken from the Pipe Shop on a daily basis and delivered to the fabricated pipe marshaling yard and then routed for coatings, if required, or containerized if no coatings are required. The new metal containers being used replace the old 4’ x 8’ wooden pallets and each has a capacity of roughly 6 or 7 to 1 over pallets, further reducing the physical storage area required (MC-7 & 8). Record keeping is accomplished by manually posting a PD control card which is sequenced by pallet number (MC-9). The PD requirements for each pallet are taken from the piping pallet list of material produced by the Planning and Scheduling Department (MC-10). When all PD’s required to complete a pallet are received, the metal containers are banded and are delivered to the installation site during the week prior to the scheduled start of installation. This method virtually relieves the installers from material concerns and allows them to concentrate on their function.

Fabricated items, other than PD’s, were formerly fabricated in entire job sets; thus, a multi-ship contract would see many outfitting items stored for many months before delivery to the ship for installation. As with PD’s, the area required for storage was physically large and the same loss, damage and deterioration problems existed. Also, many items were moved directly from the fabricating facility to the job site, which caused the Material Control records to be incomplete.

The procedure being followed under the zone outfitting concept today very nearly parallels the system used for marshaling PD’s. With a few exceptions, fabricated outfitting pieces will not be fabricated in entire job sets, but instead will be built for only one ship at a time and in smaller groupings more compatible with the master unit schedule. As with PD’s, the fabricated outfitting item will be stored when received in metal containers by pallet code for each ship. The requirement for pallet loading will be obtained from the unit and zone pallet lists of material prepared by the Planning and Scheduling Department and modified for recording receipt and issue information (MC-11). Since pallet requirements and need dates are known, missing items can be expedited through the shops two to three weeks prior to the start installation date. This will result in fewer pallets of material being incomplete and highlighting those missing pieces for extraordinary action.

The utilization of this method will result in much tighter control of fabricated pieces, timely deliveries, and will require substantially less storage area.

VI. PURCHASED MATERIALS (WAREHOUSING)

Materials purchased directly for the job are stored in the main warehousing complex or, if permitted, outside in a designated storage area. For purposes of this discussion, materials can be roughly divided into two categories: those items required for fabrication into sub-assemblies, which method was reviewed earlier; and those items requiring installation independently on unit or on board.

The requirements for pallet loading are obtained from unit or zone outfitting lists prepared by the Planning and Scheduling Department (MC-12) . Individual lists are published for each cost code (craft) within the same pallet code. Using the master unit schedule, the Material engineer reviews pallet requirements approximately two weeks prior to the material being required at the job site, writes the proper material delivery authorization ticket, and at the same time writes a material deficiency report, if required. One week, more or less, prior to the material installation need date, the delivery authorization tickets and a copy of the material deficiency report, the original of which was forwarded to the Expediting Department when written, is sent to the various warehouse storage locations. All of the materials flow from storage to a central marshaling area in the main warehouse for grouping and containerizing by pallet code and craft. Using the outfitting material requirements lists, the warehouseman verifies that all materials required are on hand, or that missing materials are accounted for on the material deficiency report. The material and its accompanying papers are then delivered to the work site two or three days prior to the start of installation.

VII. CONCLUSION

The methods developed over the past seveal years to accommodate the zone outfitting concept have thus far proven to be both more effective and more efficient than the methodology of the past. Progress and proficiency within the Material Control Department has been rewarding to date and continued advances, especially in the realm of computerization, should increase our ability to respond to future changes with a minimum of disruption.

A PALLET NUMBER CONSISTS OF A COST CODE, A LOCATION CODE, A SERIAL NUMBER CODE AND A STAGE CODE.

ON UNIT OUTFITTING:

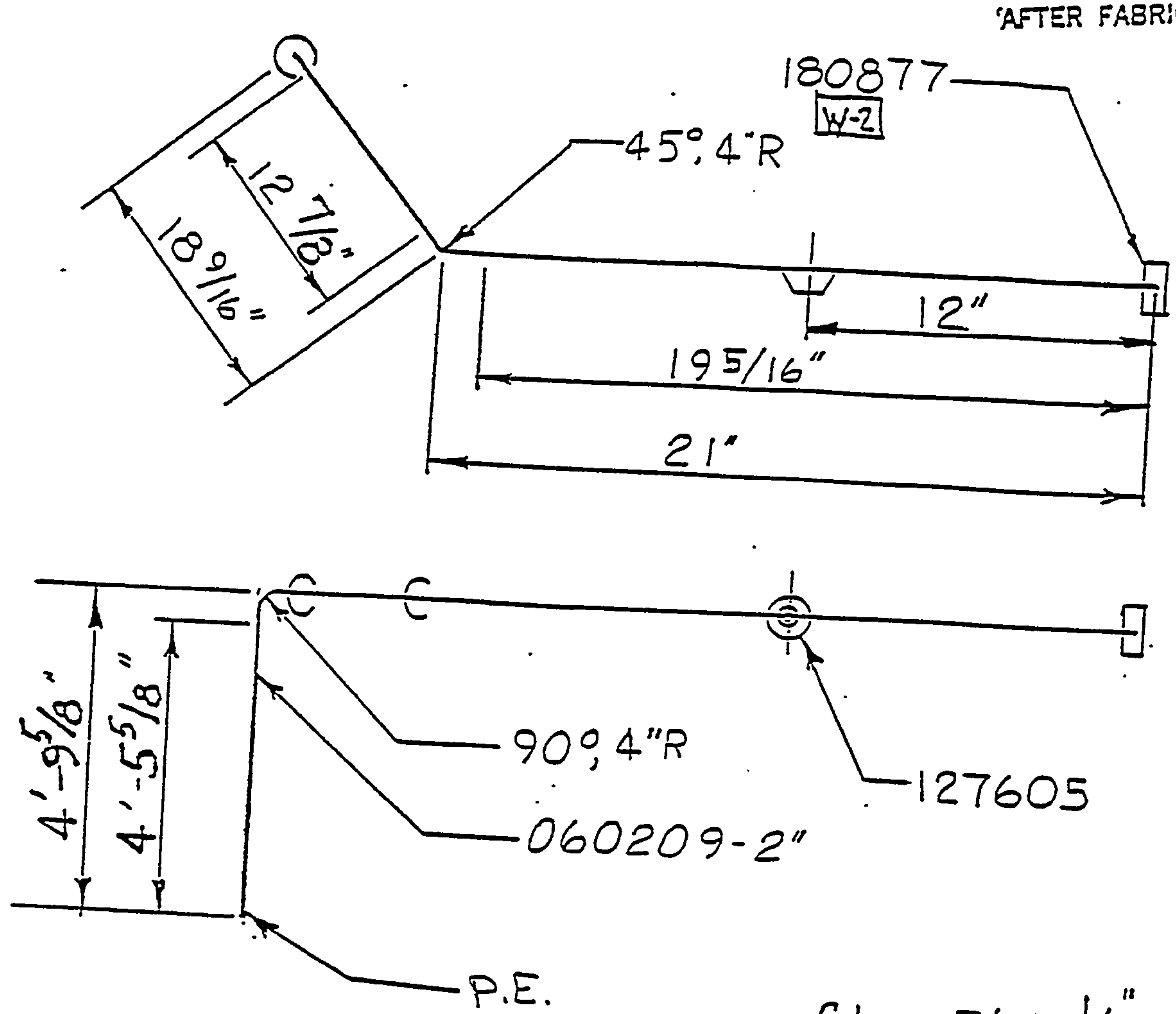
TYPICAL ON UNIT PALLET NUMBERS:

06-001-01U
07-001-01T
08-001-01V
09-001-01J

PIPE DETAIL SKETCH

P. O. NO. 1-2
NO. REQD. 1
LOC. 04-71-1

HOT DIP GALV.
AFTER FABRICATION



CL. = 7'-11 1/4"

605 COUPLET STL FORGED SW 3000 ASTM A105 VOGT SW-1211 3/4" SIZE
209 PIPE STL BW XS ASTM A53 2
877 SLEEVE STL WELDED SLIP-ON TYPE ASI MECH STD NO 10 2

AVONDALE SHIPYARDS, INC.
P.O. BOX 50280 NEW ORLEANS, LA. 70150
TITLE: PLUMBING & INT. DK. DRNS.
QTRS. "C" DK. & ABOVE - P/D

JOB NO. C6-0750
DWG NO. 48 09 142
DWN SAW
REVISION

SHEET 5

MC-2

DATE 2/17/81 P.O.NO.

LIST OF MATERIAL QUANTITY (1) SHIP REQ.NO. 6247F

PC. MK.	QTY	DESCRIPTION	UNIT PRICE	TOTAL PRICE
000180809	16	BHD & DECK PENETRATIONS STEEL WT & OT ASI MECH STD NO 11 3 IPS		
000180876	43	SLEEVE STL WELDED SLIP-ON TYPE ASI MECH STD NO 10 1 1/2		
000180877	56	SLEEVE STL WELDED SLIP-ON TYPE ASI MECH STD NO 10 2		
000180879	42	SLEEVE STL WELDED SLIP-ON TYPE ASI MECH STD NO 10 3		
000180881	2	SLEEVE STL WELDED SLIP-ON TYPE ASI MECH STD NO 10 4		
000181159	4	VENT ANTI-SIPHONIC PVC BODY MONEL SCREEN MIN VACUUM TO VENT 1" WATER MIN PRESSURE TO SEAL 1" WATER 3/4 FPT		
000181612	21	DECK DRAIN STL SOCKET WELD TATE 60-160 W/BRASS STRAINER GALV WITHOUT TRAP AND BAFFLE 2		
101000284	4	NUT STEEL GALV HVY HEX MIL-B-857A-5 ASTM A307 ANSI B18.2.2 5/8 11UNC-2B		
101011109	4	BOLT STL GALV HH MIL-B-857A-5 TY 2 GR 2 ASTM A307 GR B 5/8 11UNC-2A X 3		

DR.	AVONDALE SHIPYARDS, INC. P.O. BOX 50280 NEW ORLEANS, LA. 70150	CUSTOMER COGEN MARINE, INC.	
CKD.	TITLE PLUMBING & INT. DK. DRNS.	JOB NO. C8-0750	
APPD.	QTRS. "C" DK. & ABOVE - L/M	DWG.NO 46 08 141	REV. 2

CODE 0618 NO OF VESSELS 2 DATE 2/17/81 SHEET 8

MC-3

CE750 DWG. NO. 48-08-142 TITLE OF DRAWING PLBG & INT DK DES QTRS. "C" DK & ABOVE REV. NO.

PC. NO.	TOTAL	QTY.	SKETCH	QTY.	SKETCH	QTY.	SKETCH	QTY.	SKETCH	QTY.	SKETCH	QTY.	SKETCH	QTY.	SKETCH	QTY.	SKETCH	QTY.	SKETCH	QTY	SKETCH
070111	1	1	PD15																		
090113	8	7	PD25	1	PD26																
090211	1	1	PD15																		
093609	4	2	PD11	1	PD13	1	PD32														
127605	6	1	PD1	1	PD5	1	PD6	1	PD10	1	PD14	1	PD18								
133429	1	1	PD13																		
180876	2	2	PD20																		
180877	CONT."	1	PD1	1	PD3	1	PD4	1	PD5	1	PD6	2	PD7	1	PD8	1	PD9	1	PD10	1	PD12
180877	17	2	PD14	1	PD16	1	PD17	1	PD19	1	PD20										
180879	1	1	PD24																		

PIPE DETAIL SUMMARY - "SHOP LOAD"

MC-4

I. JOB PIECEMARK SEQUENCE

JOB NO	PIECEMARK	DRAWING	QUANTITY
C10015	000093604	48 0440	2
C10015	000093604	48 0450	4
C10015	000093604	48 1010	20
C10015	000093604	48 1020	191
C10015	000093604	55 0130	6
C10015	000093604	55 0140	20
PCM TOTAL			329
C10015	000093605	38 0210	30
C10015	000093605	45 0110	12
C10015	000093605	45 0130	8
C10015	000093605	48 0110	2
C10015	000093605	48 0210	15
C10015	000093605	48 0430	5
C10015	000093605	48 0440	4
C10015	000093605	48 0450	6
C10015	000093605	48 1010	10
C10015	000093605	48 1020	290
C10015	000093605	55 0110	8
C10015	000093605	55 0130	25
C10015	000093605	55 0140	15
PCM TOTAL			430
C10015	000093606	38 0210	13
C10015	000093606	45 0130	15
C10015	000093606	48 0110	4
C10015	000093606	48 0210	16
C10015	000093606	48 0310	10
C10015	000093606	48 0420	8
C10015	000093606	48 0430	2
C10015	000093606	48 0450	4
C10015	000093606	48 1010	8
C10015	000093606	48 1020	170
C10015	000093606	48 1710H	136
C10015	000093606	55 0110	2
C10015	000093606	55 0130	18
C10015	000093606	55 0140	25
PCM TOTAL			431
C10015	000093607	38 0210	16
C10015	000093607	45 0130	40
C10015	000093607	48 0110	3
C10015	000093607	48 0440	2
C10015	000093607	48 1020	72
C10015	000093607	55 0110	1
PCM TOTAL			134
C10015	000093608	38 0210	4
C10015	000093608	45 0110	14
C10015	000093608	45 0120	27
C10015	000093608	45 0130	5

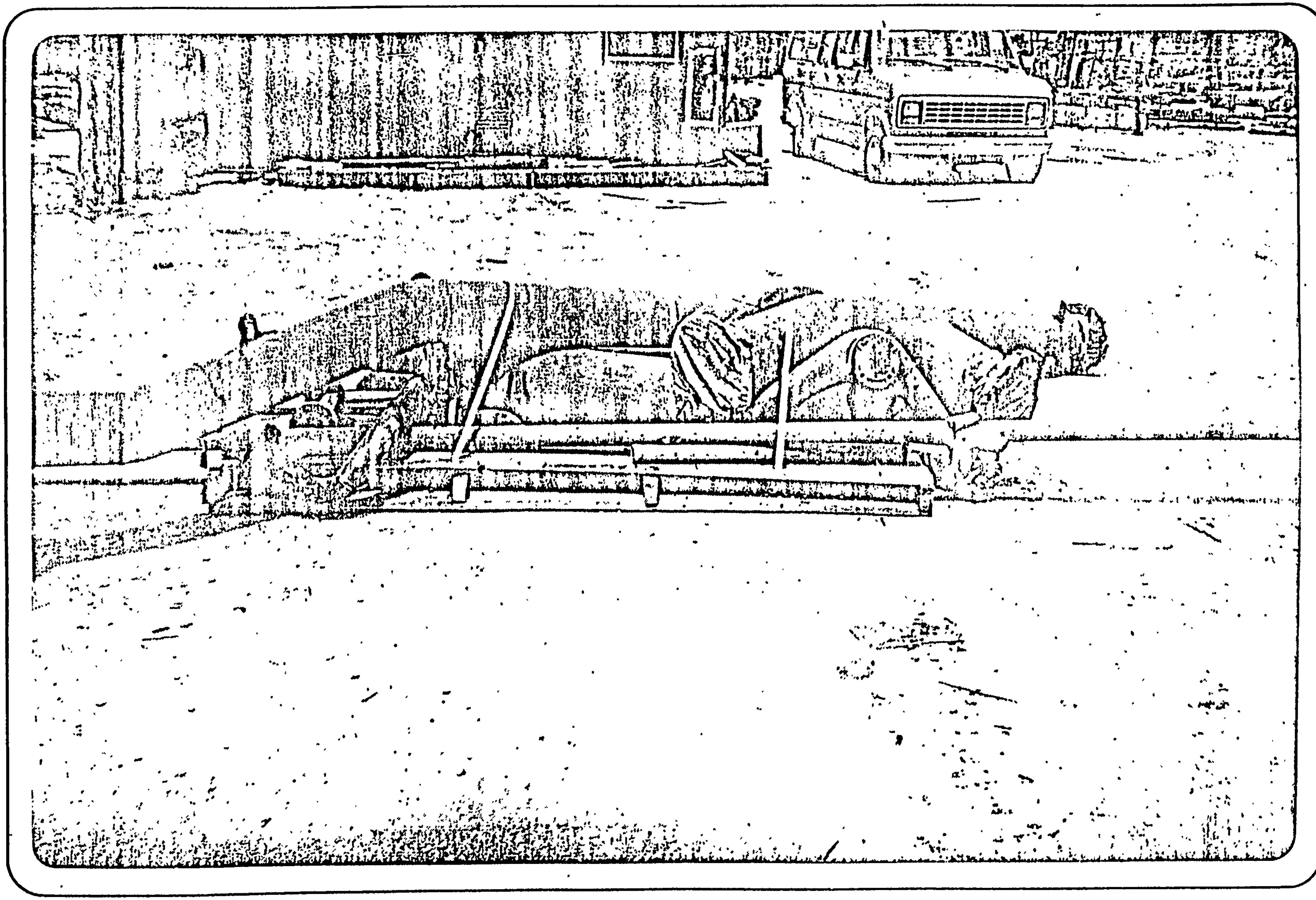
WEEKLY PIPE DETAIL SHOP LOAD

A V O N D A L E   S H I P Y A R D S,   I N C.

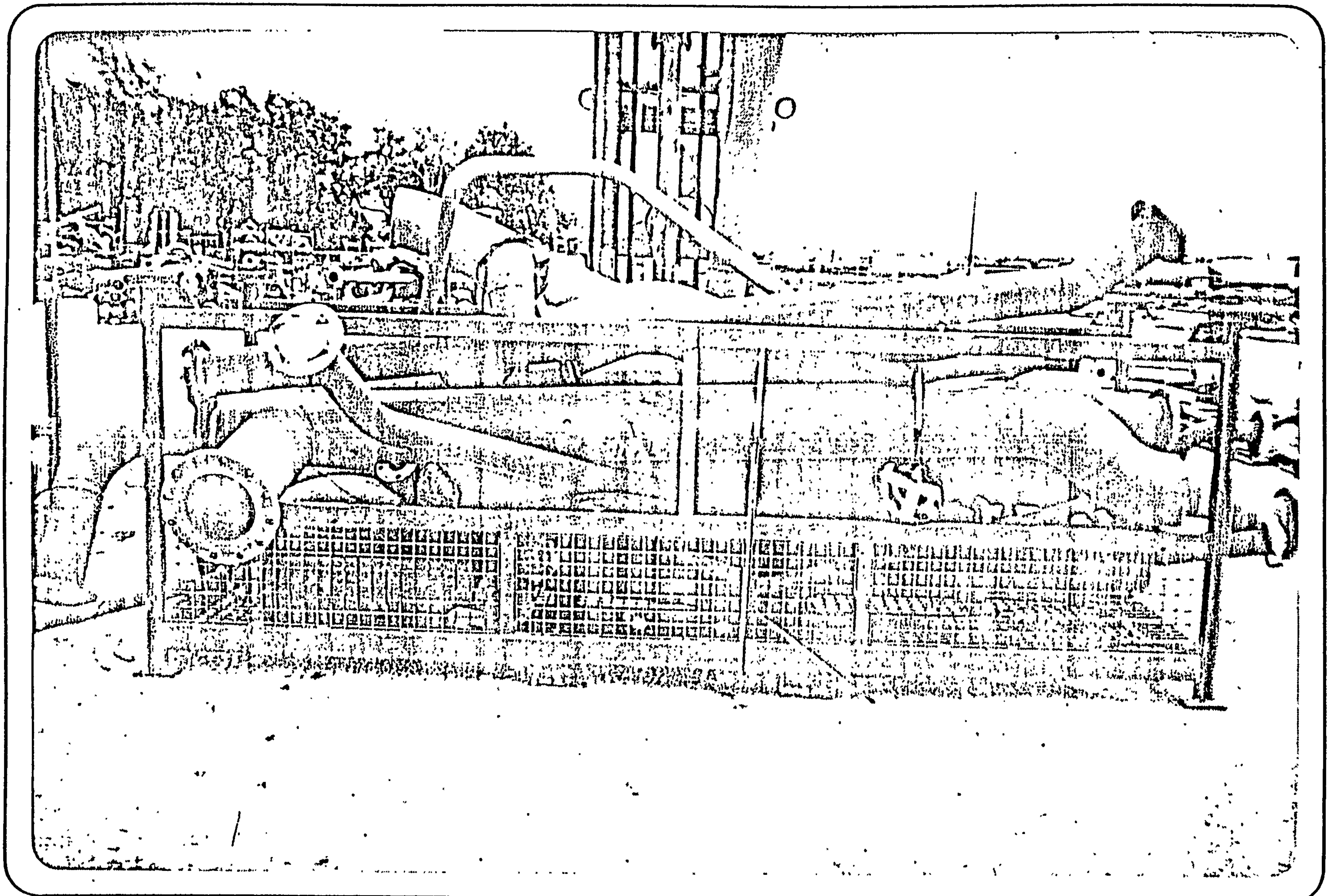
M A T E R I A L   L I S T I N G
RELEASE DATE 04/02/62

PD	PD DESCRIPTION		QUANTITY	PIECEMARK	PIECEMARK DESCRIPTION	NO REQ'D	S O NUMBER
PD165-06008047-2335	233506008047	0608	1.00000	000070110	FLANGE STL SLIP-ON 150 A	2	0000108420
PD167-06008047-2335	233506008047	0608	2.00000	000070110	FLANGE STL SLIP-ON 150 A	1	0000108370
PD024-06008047-2335	233506008047	0601	1.00000	000070113	FLANGE STL SLIP-ON 150 A	1	0000108270
PD124-06008047-2335	233506008047	0609	1.00000	000070113	FLANGE STL SLIP-ON 150 A	1	0000108530
PD166-06008047-2335	233506008047	0609	1.00000	000070113	FLANGE STL SLIP-ON 150 A	1	0000108310
PD061-06008047-2335	233506008047	0601	1.00000	000070115	FLANGE STL SLIP-ON 150 A	1	0000108390
PD011-06008047-2335	233506008047	0608	1.00000	000070115	FLANGE STL SLIP-ON 150 A	1	0000108240
PD114-06008047-2335	233506008047	0608	1.00000	000070115	FLANGE STL SLIP-ON 150 A	1	0000108650
PD016-06008047-2335	233506008047	0603	2.00000	000070116	FLANGE STL SLIP-ON 150 A	1	0000108300
PD017-06008047-2335	233506008047	0603	1.00000	000070116	FLANGE STL SLIP-ON 150 A	1	0000108600
PD020-06008047-2335	233506008047	0604	1.00000	000070116	FLANGE STL SLIP-ON 150 A	1	0000108210
PD023-06008047-2335	233506008047	0603	2.00000	000070116	FLANGE STL SLIP-ON 150 A	1	0000108430
PD116-06008047-2335	233506008047	0609	1.00000	000070116	FLANGE STL SLIP-ON 150 A	1	0000108250
PD119-06008047-2335	233506008047	0609	1.00000	000070116	FLANGE STL SLIP-ON 150 A	1	0000108640
PD120-06008047-2335	233506008047	0609	1.00000	000070116	FLANGE STL SLIP-ON 150 A	1	0000108360
PD034-06008047-2335	233506008047	0612	1.00000	000070409	FLANGE STL SOCKET WELD 1	2	0000108570
PD050-06008047-2335	233506008047	0612	1.00000	000070409	FLANGE STL SOCKET WELD 1	1	0000108590
PD128-06008047-2335	233506008047	0609	1.00000	000070409	FLANGE STL SOCKET WELD 1	1	0000108480
PD129-06008047-2335	233506008047	0609	1.00000	000070409	FLANGE STL SOCKET WELD 1	1	0000108330
PD130-06008047-2335	233506008047	0608	1.00000	000070409	FLANGE STL SOCKET WELD 1	1	0000108580
PD118-06008047-2335	233506008047	0609	1.00000	000091316	ELL 90 STL BW STD SMLS AS	1	0000108250
PD119-06008047-2335	233506008047	0609	1.00000	000091316	ELL 90 STL BW STD SMLS AS	1	0000108640
PD120-06008047-2335	233506008047	0609	1.00000	000091316	ELL 90 STL BW STD SMLS AS	1	0000108360
PD016-06008047-2335	233506008047	0603	1.00000	000091416	ELL 90 STL BW XS SMLS AS	1	0000108300

MC-6



MC-7



MC-8

JOB: C1-15 | HULL: 1 | ZONE: | DWG.: 06-009-047 | PALLET: 06-009-1T

CL	PD	QTY	RECEIVED			SURFACE PREP				COATED				ISSUED			
			REC.	DATE	LOC.	QTY.	TICKET	DTD	LOC.	QTY.	TICKET	DTD	LOC.	QTY.	TICKET	DTD	REMARKS
P/P	34	1	1	5/18	39563	1	39563	5/18	P/P	1	38585	5/25	R1R65	1	13364	6/15/82	PH n.16
B	35	1	1	5/26	39225	1	39225	5/26	B/A	1	34334	6/8		1			
B	36	1	1	5/18	39564	1	39564	5/18	B/A	1	34306	6/1		1			
B	37	1	1			1				1				1			
P/P	43	1	1	5/26	39224	1	39224	5/26	P/P	1	38590	6/1		1			
B	52	1	1		39225	1	39225		B/A	1	34334	6/82		1			
P/P	60	1	1	5/18	39563	1	39563	5/18	P/P	1	38585	5/25		1			
B	66	1	1	5/26	39225	1	39225	5/26	B/A	1	34346	6/9		1			

UNIT PIPING PALLET L/M

PRODUCTION PLANNING CAT V MN ASSY ERECT SITE·

JOB # CI-015 UNIT 9 PALLET # 06-009-1T

HULL ALL ZONE M1 PALLET REQ'D AS PER SCHED.

UNIT DESCRIPTION M/E FDN. ℄

FRAMES 28-49

DRAWING 06-009-047

REV. 0 3/31/2

06-000-04

LINE	P/D	SYS	P/D	SYS	P/D	SYS	P/D	SYS	REMARKS
									* HOT DIP GALV.
									⊕ BONDSTRAND
1	34-3"	09	35-2"	12	36-2"	12	60-3"	09	X ALUM BRASS
2	43-4 (A)	10	52-2 (A)	12	66-2 (A)	01	37-3"	01	(A) ADJ. PC.
									(T) TEMPLATE

2 CORRECTED TO SUIT P/D

TOTAL P/D'S	WEIGHT	REVISION	PAGE #
8		0 2	9-T-A

MC-10

UNIT PIPING PALLET L/M

PRODUCTION PLANNING CAT V MN ASSY ERECT SITE

JOB # CI-015 UNIT 9 PALLET # 06-009-1T

HULL ALL ZONE M1 PALLET REQ'D AS PER SCHED.

UNIT DESCRIPTION M/E FDN. ℄

FRAMES 28-49

DESCRIPTION

DRAWING 06-009-047

REV. 0 3/31/2

06-000-04

REMARKS

LINE	P/D	SYS	P/D	SYS	P/D	SYS	P/D	SYS	REMARKS
									* HOT DIP GALV.
									⊕ BONDSTRAND
1	34-3"	09	35-2"	12	36-2"	12	60-3"	09	X ALUM BRASS
2	43-4 (A)	10	52-2 (A)	12	66-2 (A)	01	37-3"	01	(A) ADJ. PC.
									(T) TEMPLATE

N/ CORRECTED TO SUIT P/L

TOTAL P/D'S	WEIGHT	REVISION	PAGE
8		0 2	9-T-A

MC-11

PIPING ARRGT UNIT NO. 13 L/M

JOB NUMBER. C10C15 05/03/82
DRAWING NO. 06013076 REV.# 0
UNIT 013 PALLET 06 013 1V
QUANTITY 1 SHIP

	SIZE	PIECEMARK NUMBER	QUANTITY	COST CODE
ELL 90 THERMOSETTING RESIN RTRP REINF		000098995	1	0601
TEE THERMOSETTING RESIN RTRP REINFORC		000116636	1	0601
REDUCER THERMOSETTING RESIN RTRP REIN		000122771	1	0601
NUT STN STL AISI TYPE 316 HEAVY HEX	9UNC-2B	101000484	36	0601
NUT STN STL AISI TYPE 316 HEAVY HEX	8UNC-2B	101000586	48	0601
FLAT WASHER STN STL AISI TYPE 316 AN	DIA BOLT	101005280	48	0601
FLAT WASHER STN STL AISI TYPE 316 ANS	OLT	101005285	96	0601
BOLT STN STL HEX HD AISI TYPE 316 ANS	X 5 3/4	101007473	12	0601
BOLT STN STL HEX HD AISI TYPE 316 ANS	X 4 3/4	101007474	24	0601
BOLT STN STL HEX HD AISI TYPE 316 ANS	X10 1/4	101007476	48	0601

DESIGN ENGINEERING FOR ZONE OUTFITTING
AVONDALE SHIPYARDS, INC.

ACCURACY CONTROL INTERFACE

Prepared by: JIM TAYLOR and WALTER WEIDMAN

DESIGN ENGINEERING FOR ZONE OUTFITTING
ACCURACY CONTROL INTERFACE

1. INTRODUCTION

If a poll of shipyard employees were to be taken with the purpose of discovering what was thought to be the most important problem with which such workers are confronted, it is quite likely that the number of problems presented would roughly coincide with the number of persons polled. And it is probable that all of the problems brought up would be worthy of considerable attention. But what might very well be the greatest problem for all shipyard employees, in the opinion of this writer, might very well be passed over completely. That problem is poor communication. And it is probable that most of the persons polled would not consoler this particular problem to fall within the realm of “Accuracy Control.” But a well conceived and operated Accuracy Control department will spend much of its time doing just this.

Briefly, let’s delve into the semantics of that title, “Accurracy Control.” The word “accuracy” connotes the development of something that coincides exactly with all design dimensions and details. While no such exactness could be expected to actually exist, it is the first function of an Accuracy Control department to help in the establishment of realistic goals in the area of “accuracy” within which a shipyard production department can operate, with proper consideration being given for the demands of both quality workmanship and good economics.

An Accuracy Control Engineer might be more aptly called a Statistical Engineer. The “statistician” determines the goals to be achieved and the “engineer” develops the controls necessary to achieve these goals. It then remains only for this set of information to be properly and precisely presented to the various agencies of the shipyard so that the necessary controls can be implemented.

This latter area of work, Communications, can be the most demanding because it requires such detailed and documented and effectively presented information, not only just to make a case in point but to present the information in such a way and with all information so conclusive that it will permit the overcoming of pre-conceived notions that might run counter to it.

The restrictions placed on us by time and the limited background of experience of the individuals involved in this discussion do not permit an exhaustive exploration of the statistical nature of Accuracy Control. Nor is it necessary, since so much that is truly academically oriented has been written on this subject. Today, we would like rather to touch on only the practical applications of Accuracy Control and discuss the results, frequently immediate in nature, that might be expected from a well operated Accuracy Control department.

One last thing should perhaps be said about Accuracy Control at this time. The implementation of an Accuracy Control program necessitates the existence of a basic philosophy in management that is committed not to just doing a job properly, but is rather committed to doing that job properly the very first time. Any other philosophy is a commitment to rework, and the elimination of rework is the job of Accuracy Control.

The continued operation of an effective Accuracy Control program will virtually assure that this philosophy of doing a job right the first time will ultimately pervade all areas of work.

II. ACCURACY CONTROL IN THE SHIPFITTING DEPARTMENT

A) GENERAL

The primary goal of Accuracy Control in the Shipfitting Department is the development and implementation of procedures that enhance the construction process of completed ship units so that they will, within prescribed tolerances and with a high degree of predictability, coincide with all design dimensions and details, thereby minimizing the amount of rework on units at the time of erection. Secondary goals are the development and implementation of procedures that enhance the burning process of individual pieces and the construction processes of sub-units and partial sub-units so that they will, within prescribed tolerances and with a high degree of predictability, coincide with all design dimensions and details, thereby minimizing the amount of rework in the sub-assembly, main assembly and final main assembly.

These goals are achieved through a three-fold effort:

- Checks

- Controls

- Statistics

These efforts should have a dual impact: the improvement of immediate work and the improvement of future work (see Fig. l-l). Although these are distinct and separate activities, they are so thoroughly interrelated that any one cannot be effectual without the involvement of the other two.

1) CHECKS

Checks are utilized for three primary purposes:

a) The isolation of specific problems that present a demand for controls.

b) The monitoring of construction to insure that:

(1) proper controls are being utilized

(2) controls are, in fact, effective

c) The monitoring of construction to assist in the minimizing of human errors.

2) CONTROLS

Controls are employed for the sole purpose of enhancing existing work practices. Control might be called the magic word in Accuracy Control, but it is, in reality, the magic word in any type of endeavor. The most necessary prerequisite for success in any venture whatsoever is a predictable end result. It is control that makes an end result predictable, whether that control be over Personnel, Machinery, Systems, or even Yourself. A lack of control means literally that something is “out of control,” resulting in a very poor degree of predictability.

3) STATISTICS

Statistics may be divided into two categories:

a) The development of statistics that are applicable to shipfitting work throughout the ship.

b) The development and maintenance of statistics applicable to a specific unit. In other words, a unit history.

4) COORDINATION OF ACTIVITIES

The coordination of these activities is graphically displayed in Figures 1-2 through 1-5. Figure 1-2 indicates that without the utilization of an Accuracy Control Program, a poor product is the predictable end result, both for immediate and future work. Figure 1-3 indicates the implementation of checks. Checks alone cannot improve the end product. Figure 1-4 indicates the development and implementation of controls in addition to checks. This results in an improved product for immediate work but develops slight potential for the improvement of future work. Figure 1-5 indicates the results that may be expected with the implementation of a well coordinated Accuracy Control Department, utilizing checks, controls and statistics.

The results from this are not only a good product in the immediate work nor the potential for a good product in the future work, but the potential has also been developed for improved design concepts, improved engineering concepts and improved production concepts.

The amount of time spent on each of these three distinct but interrelated activities will vary widely, contingent upon many factors such as the stage of development of the Accuracy Control Department or the complexity of the work at hand. In the early stages of the development of an Accuracy Control Department, it is likely that checks will be the single most important activity. Initially, the checks are necessary to develop a cognizance of all the problems that are at hand. As these various problems are recognized and evaluated, controls may then be developed and implemented to alleviate the problems. As the work progresses and the effect of controls becomes pronounced, the need for checks should begin to taper off until ultimately it is used primarily as a monitoring procedure. Similarly, in the early stages of development of an Accuracy Control Program, a very considerable amount of time will be utilized in the development of generally applicable statistics. As these statistics are evaluated and utilized in the development of controls, the need for statistics will also tend to taper off. The maintenance of unit histories must be a continuing effort.

B) OUTLINE OF ACCURACY CONTROL ACTIVITIES

1) Controls

a) Control Lines, Control Points and Backside Marking

b) Burning Procedures

c) Uniform Shrinkage Factors

d) Construction Procedures

e) Erection Procedures

f) Construction Aids

2) CHECKS

a) Measuring Procedures

b) Mathematical Checking Systems

c) Forms For Report

C) DISCUSSION OF ACCURACY CONTROL ACTIVITIES

1) Controls

a) Control Lines

Control lines, otherwise called master lines or datum lines, are water lines, frame lines, or buttocks that are layed out on various components of units to facilitate the building and erection of the unit. (See Fig. 3-6.) The utilization of these lines will receive further elaboration later in this discussion.

b) Burning Procedures

The accurate burning of all pieces of units, sub-units, or partial sub-units is of primary importance because anything else is a commitment to rework. Fig. 2-3 shows several areas where this accuracy is demanded. The fit of floor stiffeners to shell longitudinal requires not only that stiffener be cut to proper length, but shell longitudinal must also be ripped to proper width. A minimum gap of 1/4" requires that each of these members be cut within 1/8" tolerance. A fit that will always insure no burning at assembly requires even closer burning tolerance.

The fit of floor to girder requires a burning tolerance of 1/32" if all of the floors are to be fitted on a unit without reburning. Unit NO. 17, the first unit completed on the Exxon contract, with the exception of one shell plate that had stock on it when it should have been neat, was completely assembled without the use of a torch during assembly.

c) Uniform Shrinkage Factors

Few activities are of greater consequence than the development of uniform shrinkage factors. Accurate burning is of little consequence without the utilization of such factors. Floors as shown in Fig. 2-3 with an excessive shrinkage factor built in would require occasional reburning to offset a cumulative build-up, even if individual floors were only 1/16" oversize. Web frames (see Fig. 2-4) require a different shrinkage factor than the longitudinal bulkhead to which they must be fitted. Specific factors must be developed for all components of a unit.

d) Construction Procedures

Proper construction procedures such as fitting and welding sequences may well offer the most possible and immediate reward for the efforts of an Accuracy Control department. This area of work will receive greater elaboration later in this discussion.

e) Erection Procedures

The Accuracy Control Department at ASI is primarily involved in work during stages prior to erection. However, erection is a principal beneficiary of the use of control lines. These lines, when layed out with predicable accuracy, are an invaluable aid in setting units at erection. Also, the elimination of stock is virtually impossible without the use of these lines.

f) Construction Aids

Various tools are utilized in the Production Department at ASI to facilitate increased accuracy of construction. These will receive greater elaboration further in this discussion.

2) Checks

a) Measuring Procedures

Accuracy Control engineers spend a great part of their time measuring - slow, methodical, painstaking, tedious measuring. This can at times seem like the most plodding of work, but it is also the most necessary of work. It is this statistical evidence from which proper controls may be developed. A typical example is a web frame. (See Fig. 2-4.) This component must be measured before the butts are welded, after the butts are welded, and after the stiffeners and face plate are welded. This is necessary in order to determine proper shrinkage factors to be utilized in the cutting of component plating. This information is also utilized in the development of assembly procedures that assist in the minimizing of deformation of the component. It may be noted that the dimensions shown on this form provide all the information necessary to make possible these evaluations.

b) Mathmetical Checking Systems

Utilizing pertinent X and Y coordinates and rather uncomplicated programs that can be fed into hand-held calculators, it is possible, with only a few measurements to develop the shape of the most common of units. Such procedures of measuring and checking have almost unlimited potential. Discussion of such procedures will take place in future seminars.

c) Forms for Reporting

The need for and the design of forms for reporting are dictated by the problem at hand. Typical of such forms is Fig. 2-4. A similar form is shown in Fig. 2-5. This is for the reporting of measurements on the longitudinal bulkhead to which web frames must be assembled. When both of these forms provide information that is identical, a first time fit is assured.

d) Establishment of Unit Profiles

This is a procedure that-can be very helpful in the determination of the finished shape of complex weldments such as innerbottom units. This procedure will receive greater elaboration further in this discussion.

3) Unit Histories

Unit histories are merely the methodical recording of all problems encountered in the production of a specific unit. This data is used in the development of procedures that will assist in the minimizing of the effect of any particular problem on subsequent units. This is particularly useful on multi-ship contracts.

III. ACCURACY CONTROL AS AN INTERFACE OF ENGINEERING

A) GENERAL

Although most of the benefits of a well coordinated Accuracy Control department are applicable primarily to the Production Department, many benefits can also be accrued by the Engineering Department. In the time available today, we will briefly explore some of these activities with an emphasis on the profound effect that they can have on an end product. The Accuracy Control program at ASI was started early in the production of a contract to build three APL Containerships. To date, the activities of the department have been largely restricted to that contract and to a contract for Exxon Product Carriers currently in work. Most of the following information was developed while working on the APL contract. Only a few areas of activity have been selected for discussion at this time, not because they are necessarily of any greater importance than other activities, but rather because they more graphically illustrate the advantages that can be derived from the functions of a well coordinated Accuracy Control program.

Time does not permit a detailed analysis of these procedures. Today, we will only attempt to touch on the highlights of the procedures and the advantages to be secured from them with more extensive details deferred for later discussion.

B) CONSTRUCTION SEQUENCES

It is probable that the most immediate and most positive improvement that can be achieved in the work process is through the development and implementation of properly conceived fitting and welding sequences. This is quite likely a valid assumption in that the complete lack of such established sequences can virtually negate all other improvements. Dozens of such sequences have been developed for use on contracts underway at ASI. A typical unit has been selected for minimal discussion at this time.

Unit No. 7 is a fairly typical innerbottom unit such as is likely to be found on most contemporary design ships. (See Fig. 3-l.) Three major areas of heat introduction, in the form of welding, present the potential for building in stresses or actually deforming this unit:

- butt welds;
  vertical welds, floors to girders;
  welding of loose shell longitudinal.

Since this unit was built upside down and the tank top was delivered to the platen fully welded with all longitudinal stiffeners fitted and welded, it in no way contributed toward any deformation of the unit. The longitudinal girders were delivered to the platen with the floors immediately outboard already fitted and welded. This, then, necessitated fitting of all girders and attached floors to the tank top, the fitting of all floors to girders immediately inboard of them, the fitting of all loose shell longitudinal, and the fitting of all shell plating to girders, floors, longitudinal, and to the tank top.

Each of these areas of fitting presented a very distinct potential for deforming the unit. No formal construction sequence whatsoever was utilized in the building of Unit NO. 7 Of Hull NO. 1. Figure No. 3-2 is a profile that was developed from that unit, shown to a scale of 1/8″ - 1′ - 0“ athwartship and full scale vertically. A crown in excess of 5/8″ developed on this unit. Other similar, but larger, units developed crowns up to 7/8″.

Various attempts were made to minimize this deformation, including the building in of a reverse crown, but most of these efforts tended to be ineffective. (See Fig. 3-3.) Ultimately, a detailed construction sequence was developed and implemented. (See Fig. 3-4.)

This procedure isolated and controlled the three basic problem areas: butt welding of all shell plates, welding of all floors to girders, and welding of all loose shell longitudinal. The procedure in no way minimized the heat introduction, but only permitted it to shrink the components in such a manner as to minimize the potential for deformation. The resulting unit on Hull No. 3 was virtually flat. (See Fig. 3-5.)

The deformation of such units as innerbottom, Unit NO. 7, resulted primarily from the introduction of heat, in the form of welding, at the shell plate side of the unit while the tank top of the unit was totally restrained by prior fitting and welding. This resulted in horizontal movement in excess of 5/16 of an inch on the shell plate side of the unit. Since the tank top side of the unit was restrained and not permitted to move, the crowning of the unit was the unavoidable result. This result is both predictable and calculatable as is shown on accompanying calculations which will be elaborated on in detail in later discussions.

The entire construction sequence was developed to permit a uniform movement of the components of the unit, thereby precluding the possibility of deformation.

C) CONTROL LINES, CONTROL POINTS AND BACKS IDE MARKING

Early in the production phase of the APL contract, it became evident that accurately located control lines on a unit would be advantageous in both the building and erection of the units. Figure No. 3-6 shows the layout of control lines on a typical tank top unit. The buttock is used for setting the unit athwartship and the frame line is used for setting the unit longitudinally. For this procedure to be practical, these lines must be located with unvarying accuracy. To enhance the potential for a high degree of accuracy, future contracts will incorporate these lines into the engineering drawings and panel line sketches that are used for building flats, decks, bulkheads, etc.

D) CONSTRUCTION AIDS

Many tools may be developed to assist the Shipfitting Department in completing accurately built units, but perhaps the one of the greatest practical value is the erection joint tape batten. These battens indicate proper position of all structural at erection joints. Where utilized properly and in conjunction with other procedures, it is possible to locate such structural within a tolerance of one quarter inch or less. This procedure has proven itself so effective on the APL contract that on future contracts, battens will be developed at all erection joints. Fig. No. 3-7 shows a backside marker. This piece of equipment permits the accurate transferal of center punch marks from the layout side of plating to the opposite side. Such accuracy is required if these lines are to be used in the erection of the ship.

IV. DISTORTIONS OF UNITS

For the simplicity of discussion, we analyzed the unit in the form of a simple beam (see Fig. 4-1 and 4- 2). Using a standard W36 x 194 beam, we derived the following comparison: tortion from welding can be compared to simple beam action when the beam is loaded with a uniformly distributed load.

From the AISC Handbook on simple beams with uniformly distributed loads:

$$\Delta \max = \frac{5wl^4}{384EI}$$

Where: Δ max = maximum deflection in the vertical direction

w = load in kips/inch

1 = length of the beam in inches

E = modulus of elasticity (30 x 106 PSI)

I = moment of inertia in inches to the fourth.

If w= .5 k/in and 1 = 480″ and I = 12,100 in^4 for a standard W36 x 194 shape, then:

$$\Delta \max = \frac{5(.5k/in)\ (1000\ lb/k)\ (480\ in)^4}{(384)(30 \times 10^6\ lb/in^2)\ (12,100\ in^4)}$$

A max = 0.9521 in = 15/16″

We can easily measure the horizontal deflection, but the vertical deflection is more difficult to determine and is very important. To determine the vertical deflection that would occur as a result of the horizontal deflection, we need to derive some more formulas.

Horizontal deflection ' Δ_H" caused by a force "P" can be described by the following formula:

$$\text{EQ. I} \quad \Delta_H = \frac{Pl}{AE}$$

Where: Δ_H = horizontal movement of the shell

P = the force in the shell

A = cross sectional area of the plate

1 = length (varies with the size and amount of tack welds)

E = modulus of elasticity.

Since stress " 6 " = P/A

then EQ.I becomes

$$\text{EQII} \quad \Delta_H = 6\frac{1}{E}$$

$$\text{but} \quad 6 = \frac{Mc}{T}$$

Where: M = moment

c = distance to the neutral axis

So: $$\text{EQIII} \quad \Delta_H = \frac{Mcl}{EI}$$ by substitution

Since $$M = \frac{wl^2}{8}$$

$$\text{EQIV} \quad \Delta_H = \frac{wl^3c}{8EI}$$ also by substitution

To obtain the vertical def ection " Δ " in terms of the horizontal deflection " Δ_H, " multiply both sides of the following equation:

$$\Delta_V = \Delta_{max} = \frac{5wl^4}{384\ EI}$$

By equation IV

$$(\Delta_V)\ \frac{wl^3c}{8EI} = \frac{5wl^4}{384\ EI}\ (\Delta_H)$$

$$\Delta_V = \Delta_H\ \frac{(0.104)l}{C}$$

To prove this equation we substituted the values we used in the Δ_{max} equation into our equation IV.

$$\Delta_H = \frac{wl^3c}{8EI}$$

When: $w = .5k/in$

$c = 17.61$ in (steel handbook)

$l = 480"$

$E = 30 \times 10^6$ PSI

$I = 12{,}100\ in^4$

$$\Delta_H = \frac{(.5k/in)\ (1000\ lb/k)\ (480\ in)^3 (17.61\ in)}{8(30 \times 10^6\ lb/in^2)\ (12{,}100\ in^4)}$$

$$\Delta_H = 0.3353 \text{ inches}$$

$$\Delta_V = {}_H\ \frac{(0.104)l}{C}$$

$$\Delta_V = (0.3353\ in)\ \frac{0.104\ (480\ in)}{(17.61\ in)}$$

$$\Delta_V = 0.9505 \text{ in} = 15/16"$$

This compares with our earlier results of 15/16″ in the equation for Δ max.

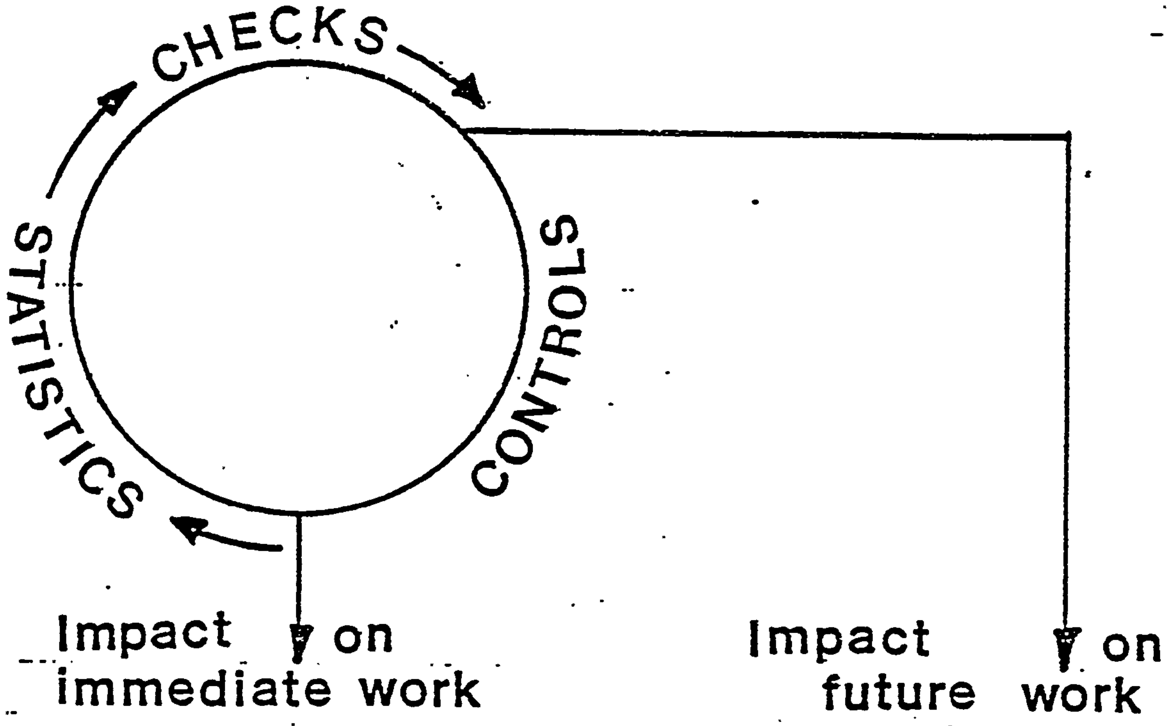

CHECKS
CONTROLS
STATISTICS
Impact on immediate work
Impact on future work

Fig. 1-1

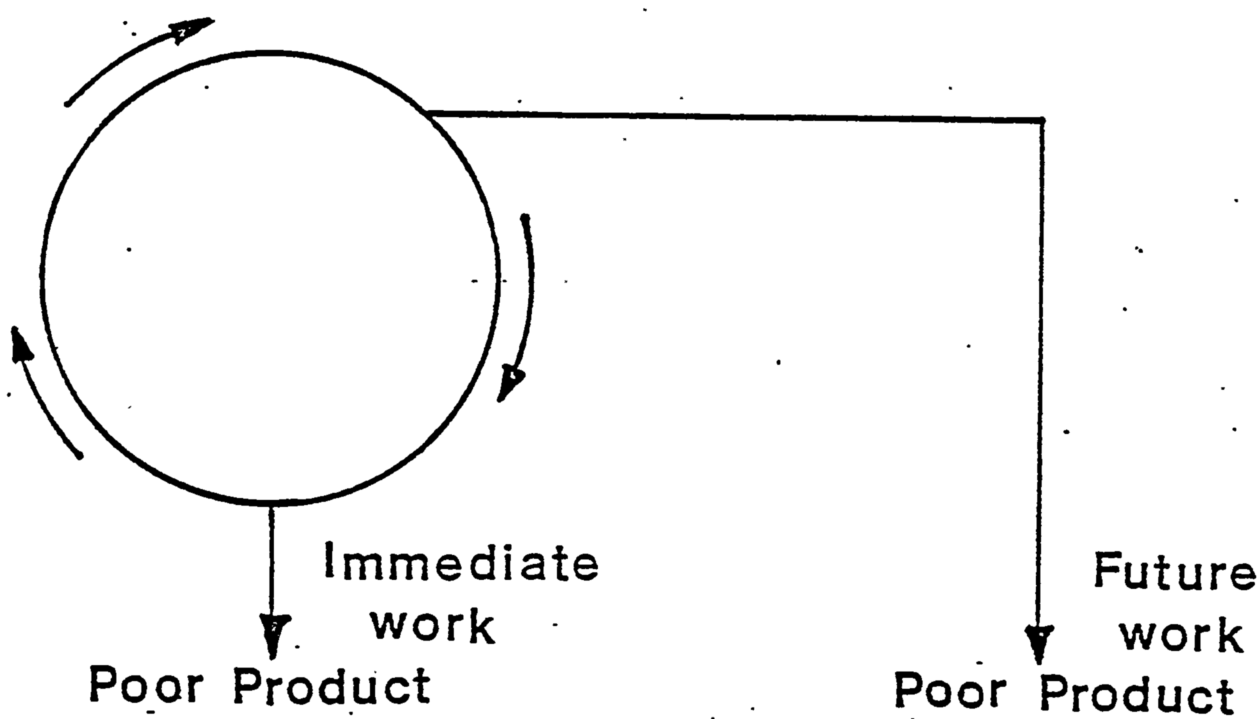

Immediate work
Poor Product
Future work
Poor Product

Fig. 1-2

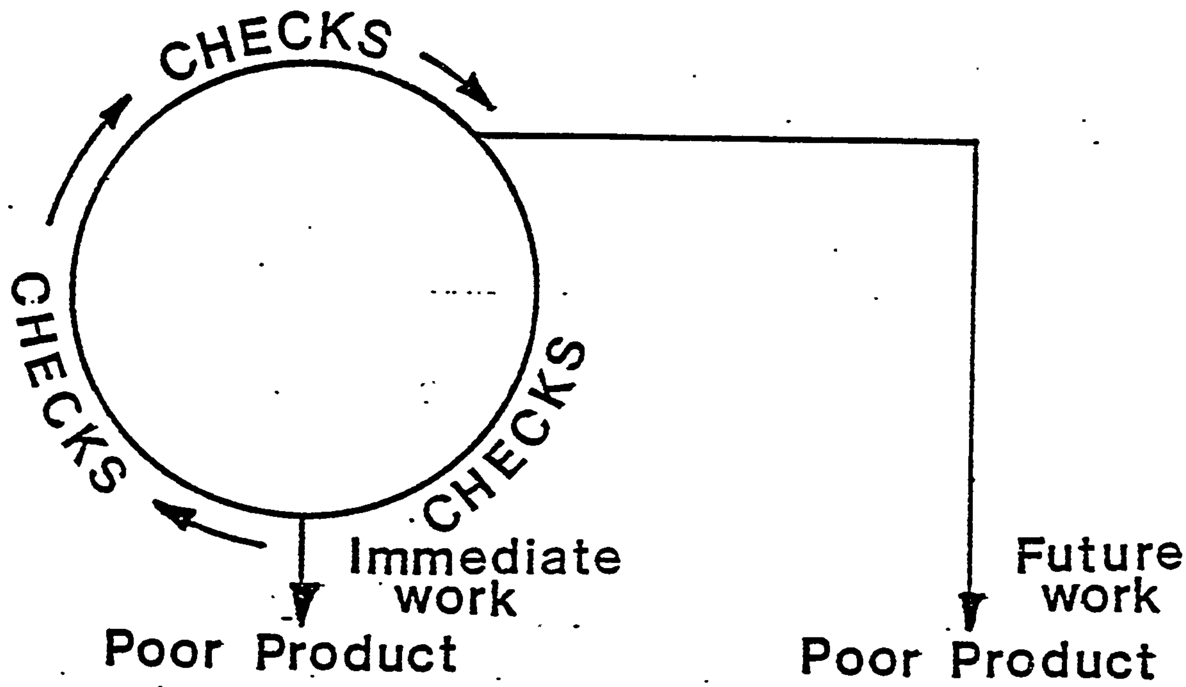

CHECKS
CHECKS
CHECKS
Immediate work
Poor Product
Future work
Poor Product

Fig. 1-3

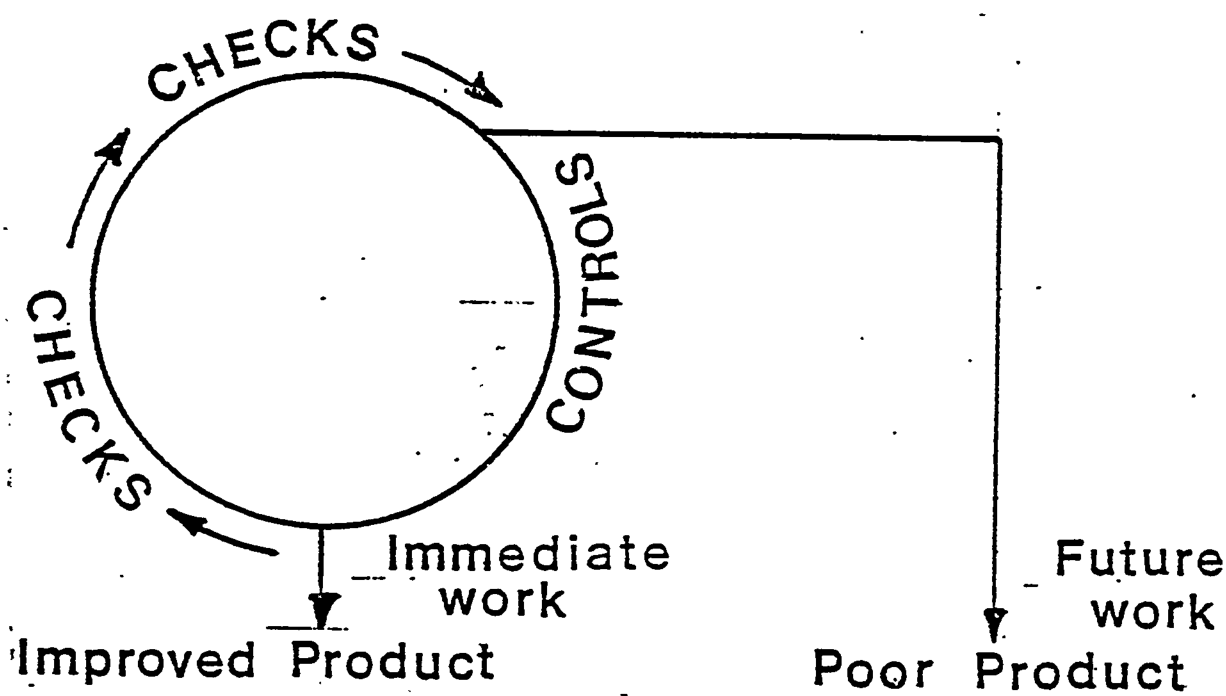

CHECKS
CHECKS
CONTROLS
Immediate work
Improved Product
Future work
Poor Product

Fig. 1-4

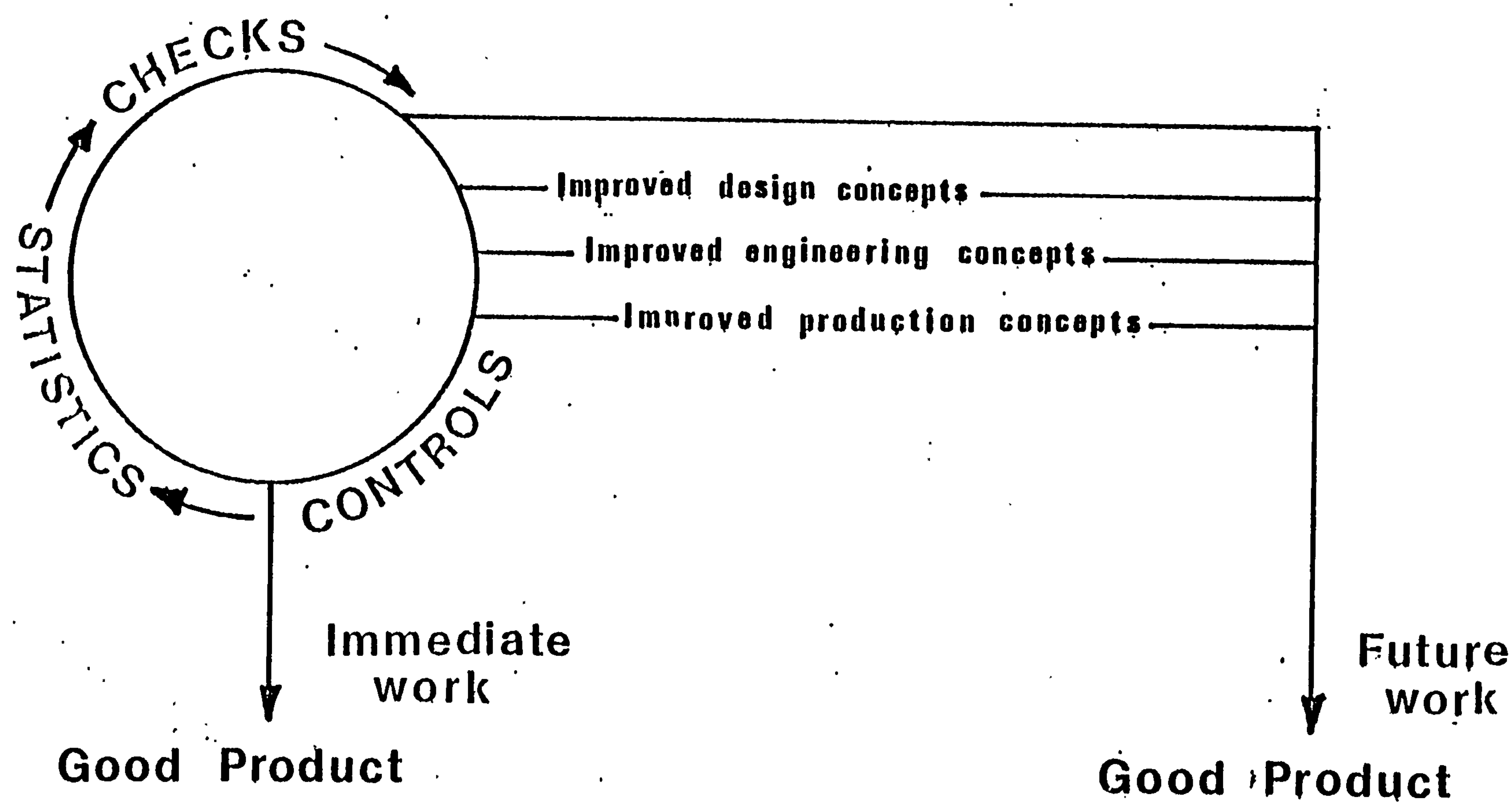

CHECKS
CONTROLS
STATISTICS
Improved design concepts
Improved engineering concepts
Imnroved production concepts
Immediate work
Good Product
Future work
Good Product

Fig. 1-5

2.0 Outline of Accuracy Control Activities

2.1 Controls

A. Control Lines, Control Potits and Backide Marking
B. Burning Procedmes
C. Uniform Shrinkage Factors
D. Construction Procedures
E. Erection Procedures
F. Construction Aids

2.2 Checks

A. Measuring Procedures
B. Mathmatical checking Systems
C. Forms for Reporting
D. Establistient of Unit Profiles

2.3 Unit Histories

A. Engineering
B. Mold Loft and Numerical Control
C. Plate Shop
   1. Burning
   2. Panel Line
D. Structurals
E. Shipfitting
F. Welding
G. Handling
H. Miscellaneous

Fig 2-1

Long. Bhd.
Unit # ________

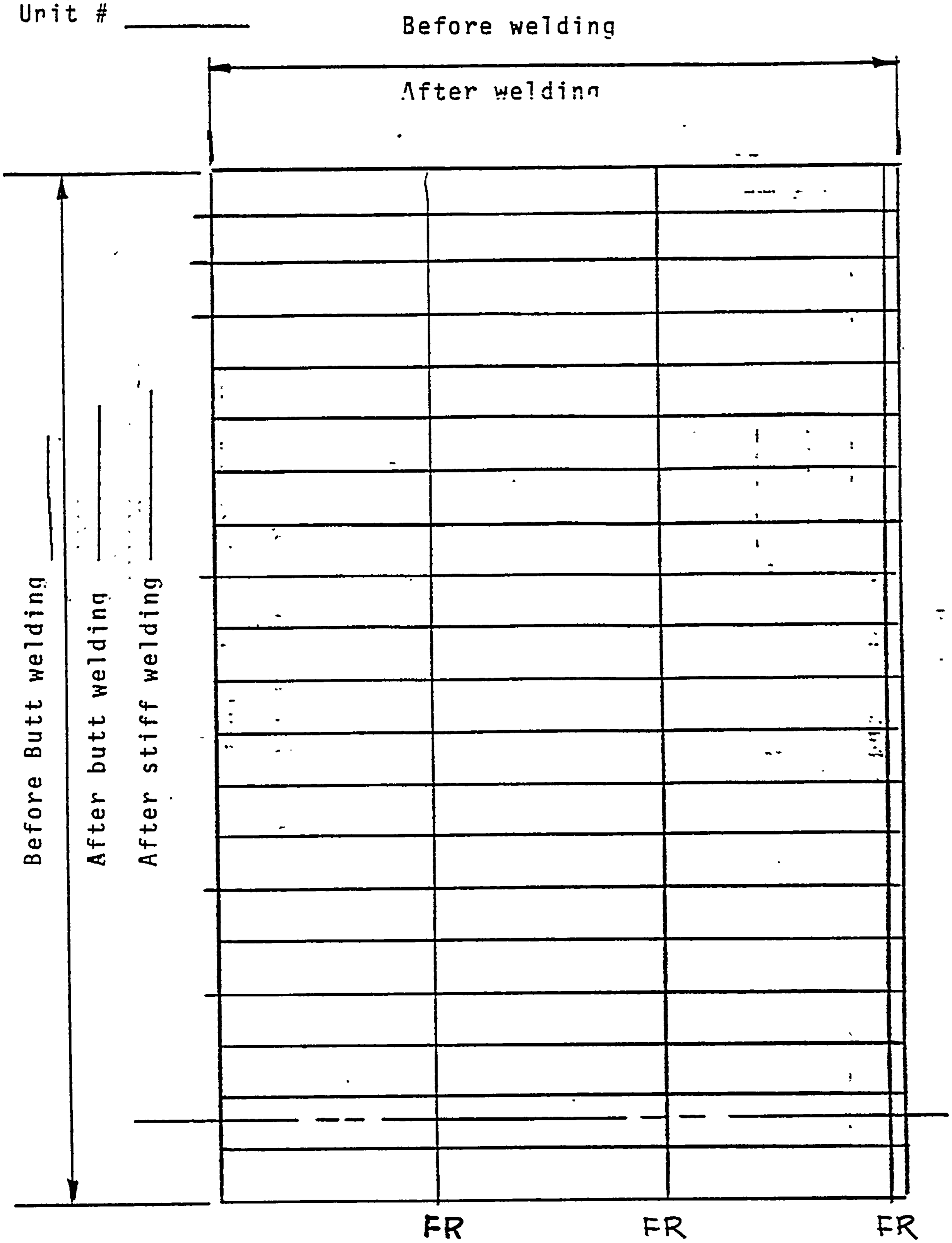


FIG 2-5

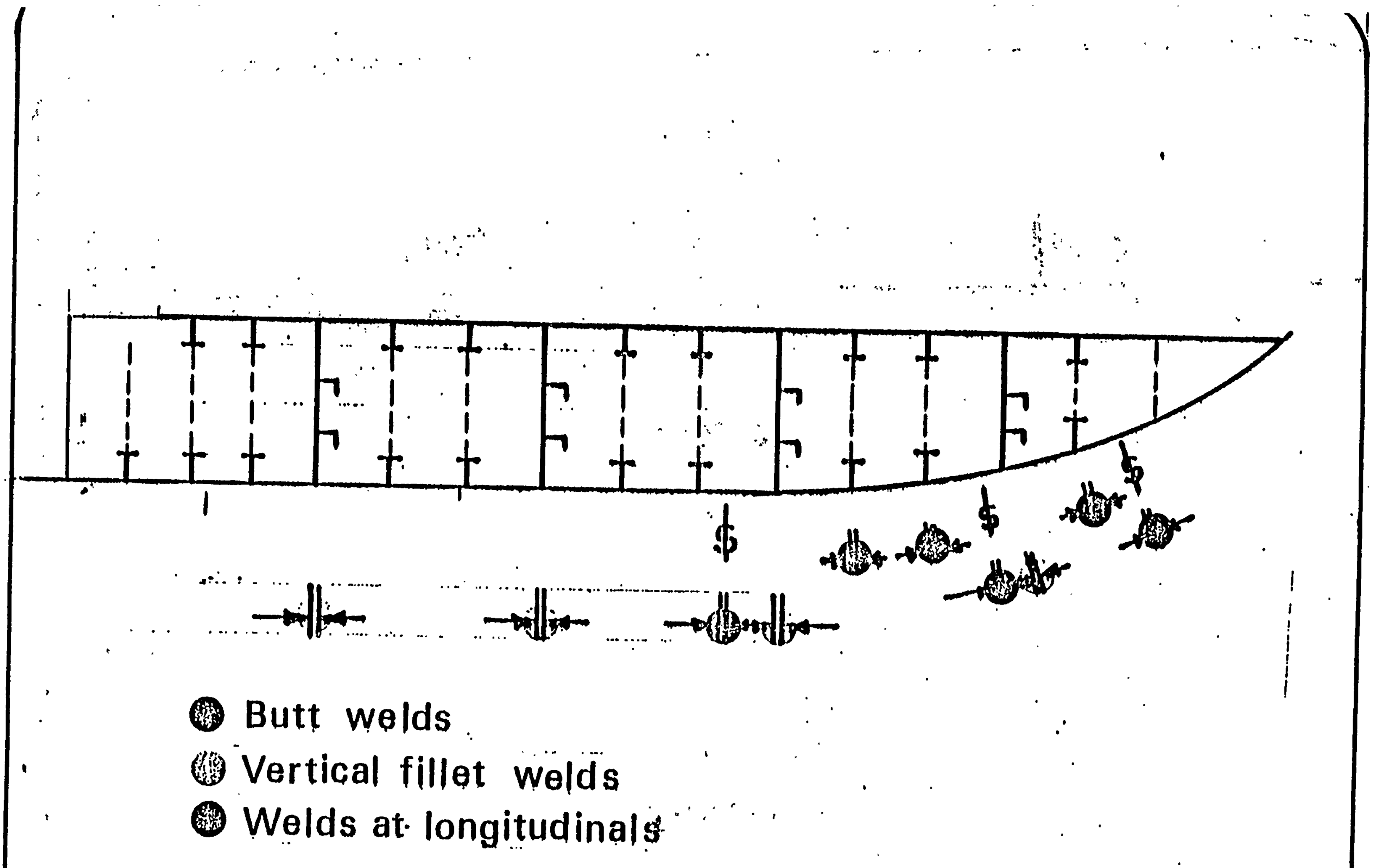


Fig. 3-1

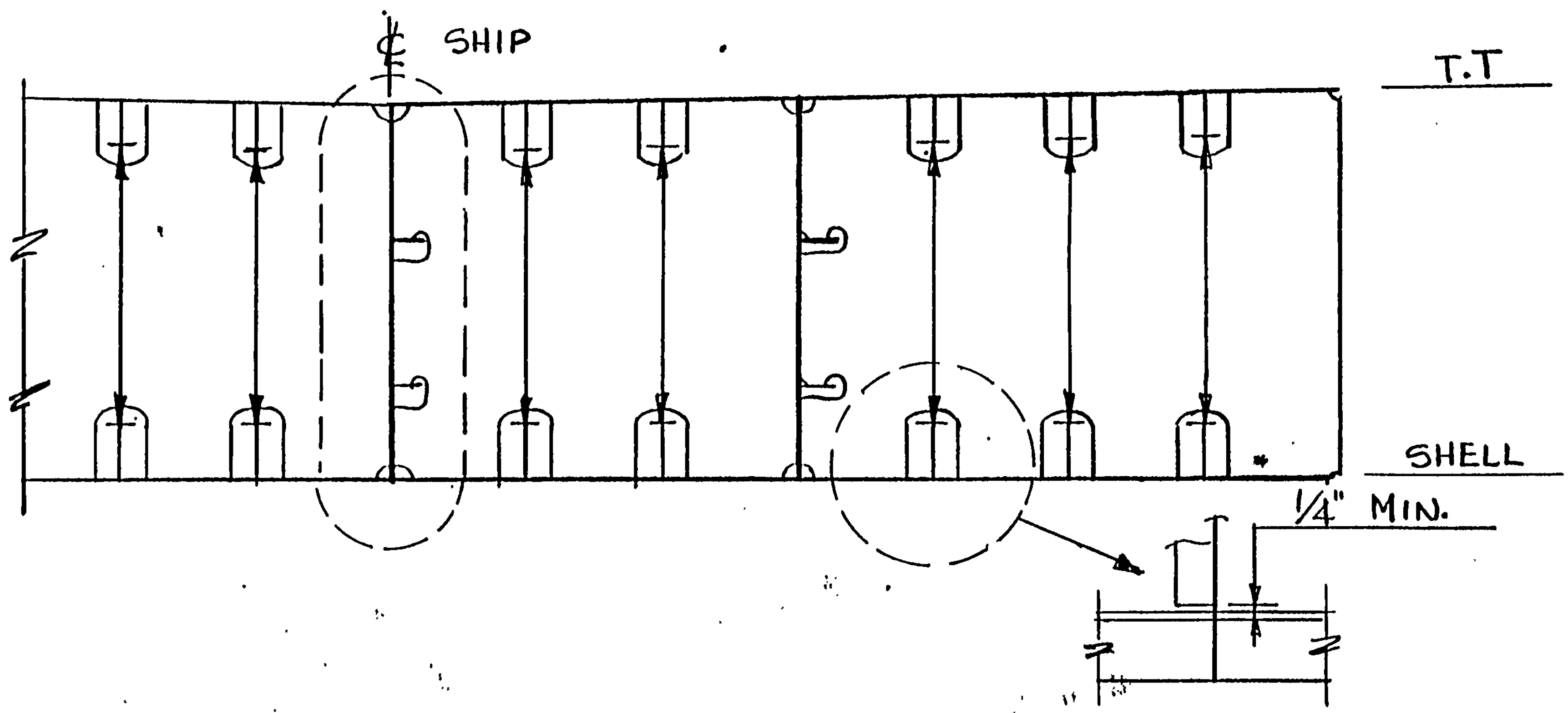


FIG. 2-3

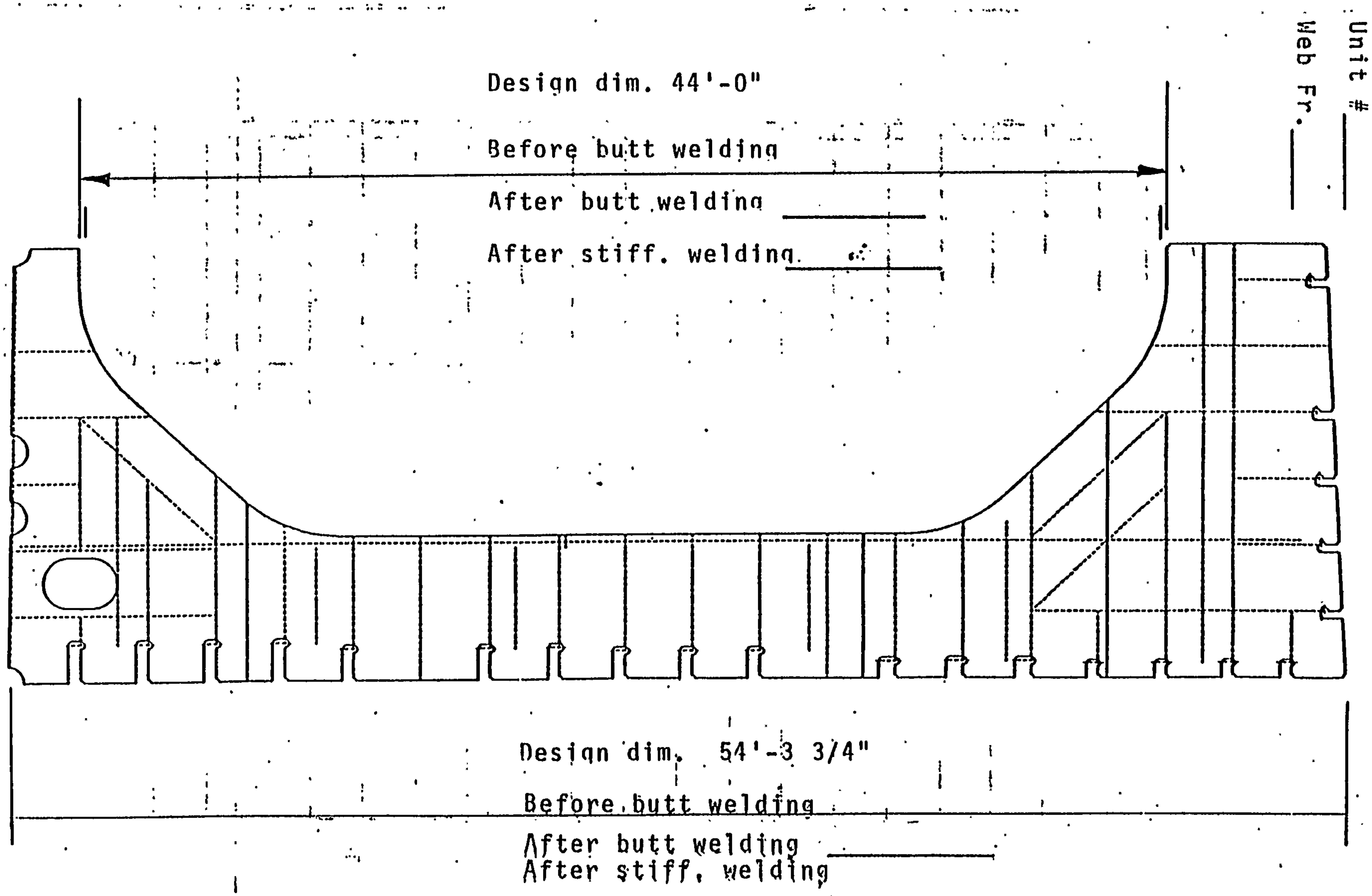

Unit #
Web Fr.
Design dim. 44'-0"
Before butt welding
After butt welding
After stiff. welding
Design dim. 54'-3 3/4"
Before butt welding
After butt welding
After stiff. welding

FIG. 2-4

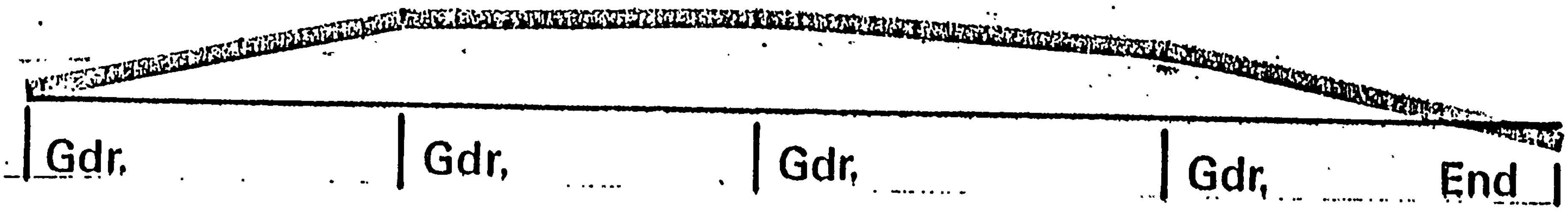


Fig. 3-2
Hull 1

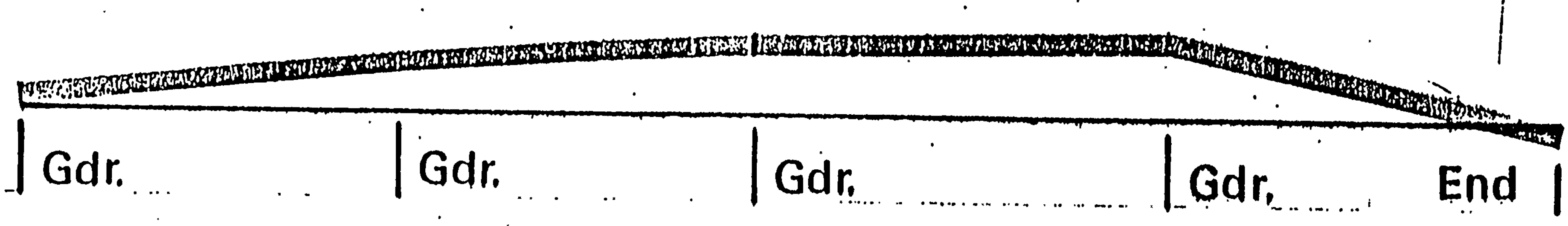


Fig. 3-3
Hull 2

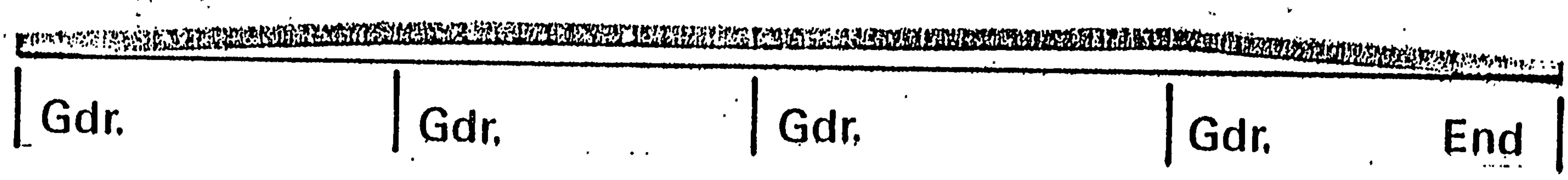


Fig. 3-4
Hull 3

Main Assembly Construction Sequence

1. Lay down tank top panels on platen.
2. Hang girders to which floors have been previously fitted and welded.
3. Fit girders to tank top. (2'-0" fwd. and aft. of each frame should left free of tacks)
4. Level unit. (Tack to platen w/clips)
5. Fit floors to girders. (Do not fit floors to tank top)
6. Weld all floors to girders, backstepping four times.
7. Fit floors to tank top.
8. Flat weld all girders and floors to tank top.
9. Fit all stiffeners, collars, brackets, clips, etc. at tank top.
10. Weld stiffeners, collars, etc., at tank top.
    Note: No piping to be installed prior to this stage of construction.
11. Hang and fit all loose shell longitudinals.
12. Weld clips or collars at shell longitudinals.
13. Hang and fit shell plate nearest to centerline of ship. (If this is a blanket, fit entire blanket, tacking to floors, girders and longitudinals)
14. Hang adjacent shell plate.
15. Weld shell plate butt.
16. Repeat procedure prescribed in item #14 for each of remaining shell plates up to extreme outboard plate.
17. Hang extreme outboard shell plate. If shell longitudinals fall under this plate, fit as previously described. Otherwise fit shell plate to floors, utilizing welding clips. (Do not fit to floors) Do not fit to tank top at this time!
18. Weld last shell plate butt.
19. Fit shell plate to tank top.
20. Flat weld shell plate to tank top.
21. Turn unit right side up and finish fitting at shell.
22. Flat weld floors, girders and longitudinals and backgouge and weld butts.
23. Check ends of all girders and longitudinals for proper alignment with adjacent units. Fair if necessary.

Fig 3-5

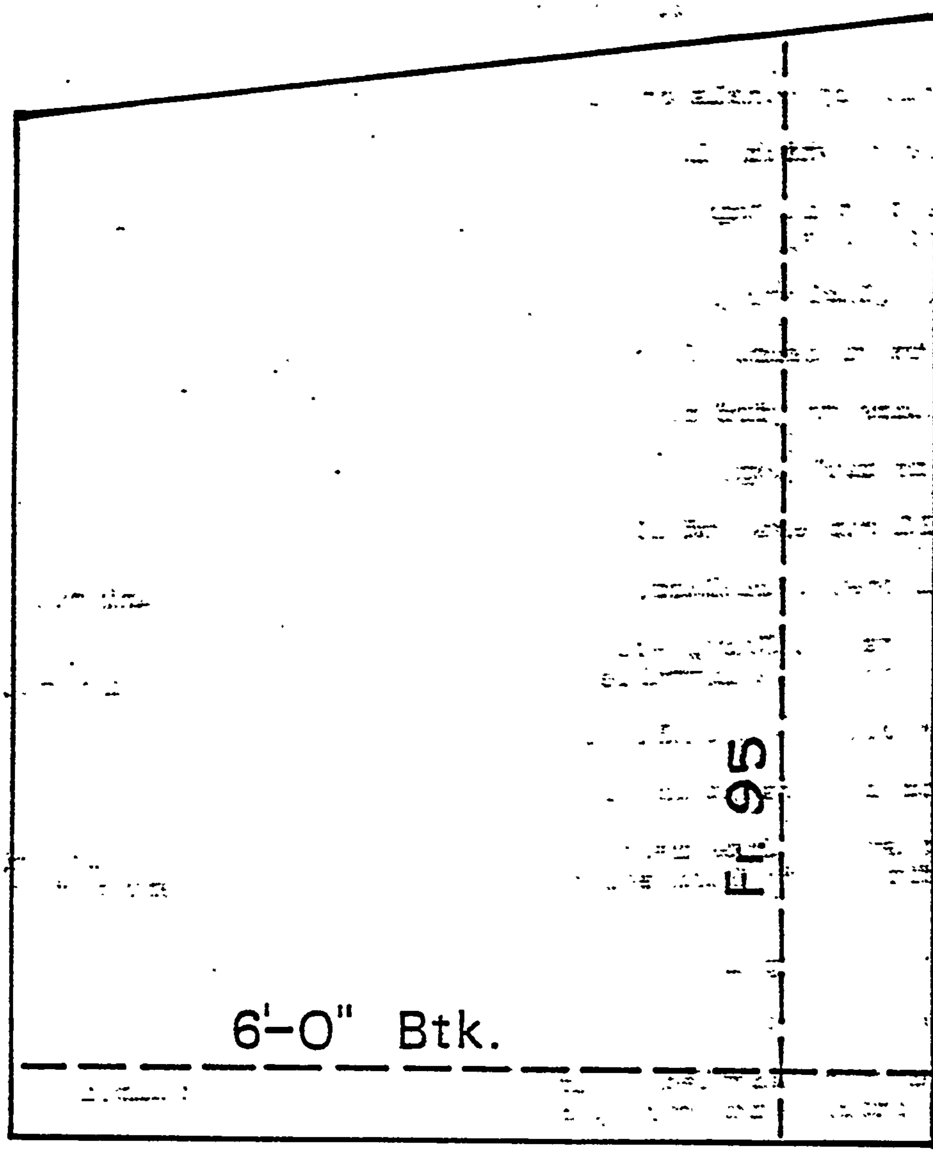


Fig. 3-6
Control lines on typical innerbottom unit

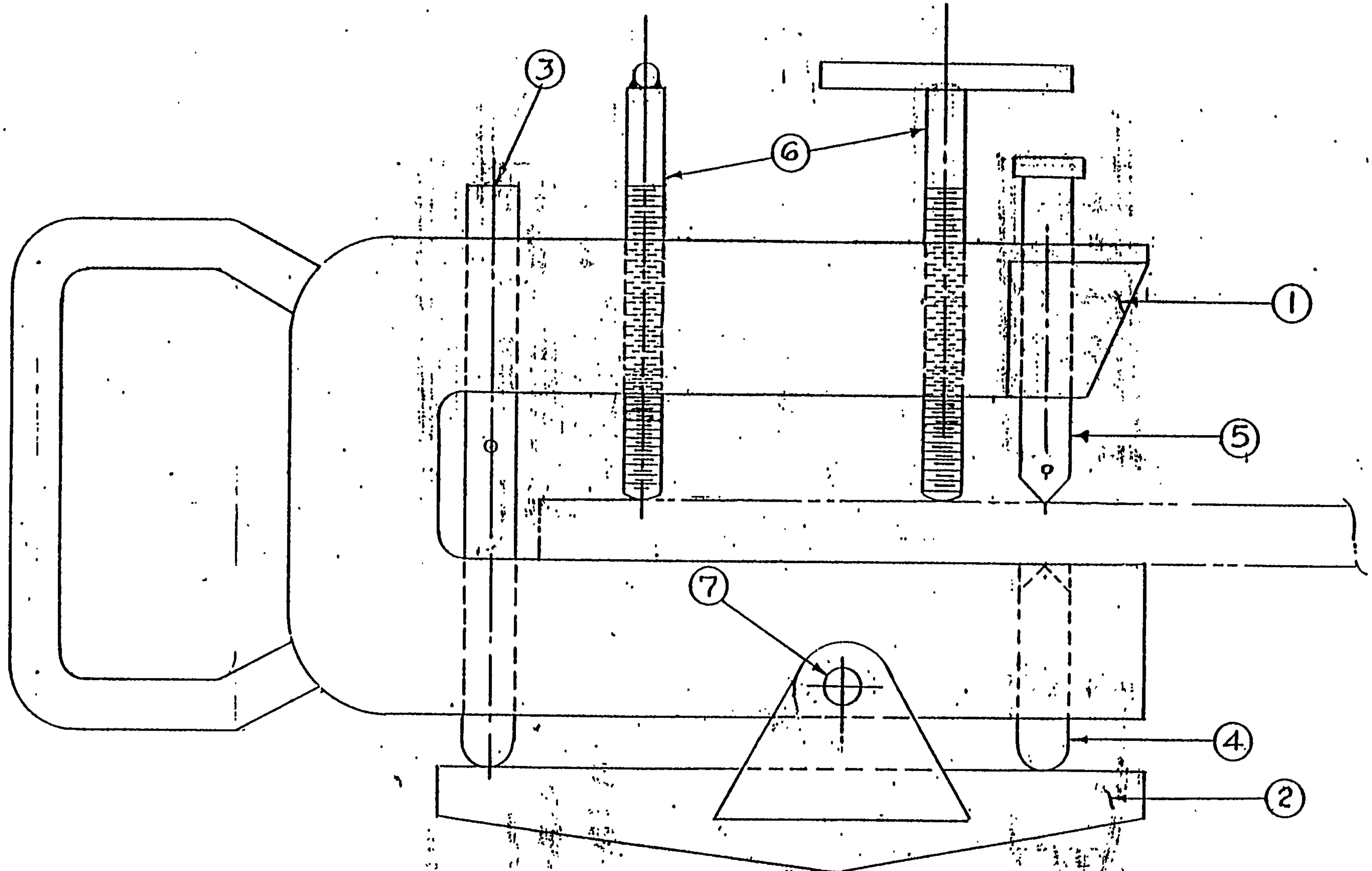


FIG. 3-7

BACKSIDE PUNCH

SH 1

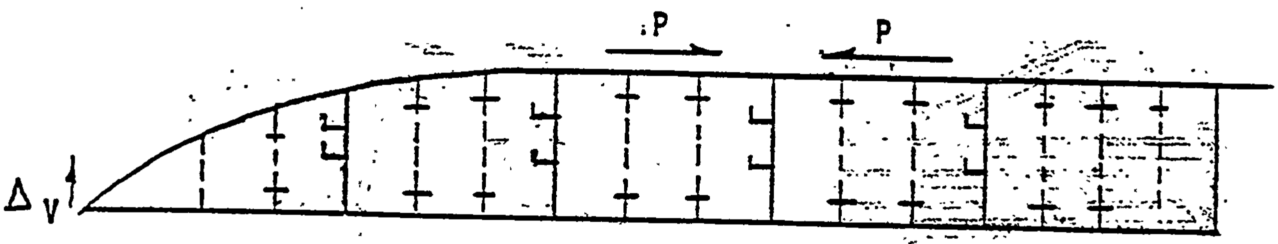


FIG. 4-1
TYPICAL INNERBOTTOM

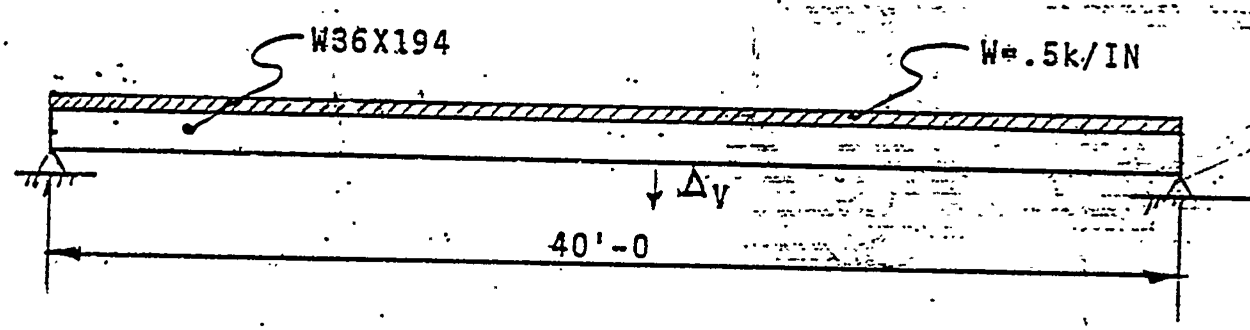


FIG. 4-2
SIMPLE BEAM